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Prof. W. C. Hoad.

W. C. Hoad.

KANSAS ACADEMY OF SCIENCE.

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TRANSACTIONS

OF THE

KANSAS

ACADEMY OF SCIENCE,

VOL. XX, PART I.

CONTAINS

LIST OF OFFICERS, PAST AND PRESENT; MEMBERSHIP LIST JANUARY 10, 1906; THE PRESIDENT'S ADDRESS; MINUTES OF THE THIRTY-EIGHTH MEETING OF THE ACADEMY; ALSO, A FEW ILLUSTRATIONS AND SOME OF THE PAPERS PRESENTED.

DECEMBER, 1905.

STATE PRINTING OFFICE,
TOPEKA, 1906.
1068

OFFICERS OF THE ACADEMY FOR 1906.

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Vice-presidents.....{ B. F. EYER.....Manhattan.
J. E. WELIN.....Lindsborg.
Treasurer.....ALVA J. SMITH.....Emporia.
Secretary.....J. T. LOVEWELL.....Topeka.

Past Officers of the Academy.

PRESIDENTS.

1869, '70.. B. F. Mudge.
1871-'73.. John Fraser.
1874-'78.. F. H. Snow.
1879, '80.. B. F. Mudge.
1881, '82.. J. T. Lovewell.
1883..... A. H. Thompson.
1884, '85.. R. J. Brown.
1886..... E. L. Nichols.
1887..... J. D. Parker.
1888..... J. R. Mead.
1889..... T. H. Dinsmore, jr.
1890..... G. H. Failyer.
1891..... Robert Hay.
1892..... E. A. Popenoe.
1893..... E. H. S. Bailey.
1894..... L. E. Sayre.
1895..... Warren Knaus.
1896..... D. S. Kelly.
1897..... S. W. Williston.
1898..... D. E. Lantz.
1899..... E. B. Knerr.
1900..... A. S. Hitchcock.
1901..... E. Miller.
1902..... J. T. Willard.
1903..... J. C. Cooper.
1904..... Edward Bartow.
1905..... L. C. Wooster.

VICE-PRESIDENTS.

1869, '70.. J. S. Whitman.
1871..... B. F. Mudge.
1872, '73.. B. F. Mudge, Dr. R. J. Brown.
1874..... J. A. Banfield, J. D. Parker.
1875..... B. F. Mudge, J. D. Parker.
1876, '77.. B. F. Mudge.
1878..... B. F. Mudge, J. H. Carruth.
1879-'82.. J. H. Carruth, Joseph Savage.
1883..... J. R. Mead, G. E. Patrick.
1884..... F. H. Snow, Joseph Savage.
1885..... E. L. Nichols, G. H. Failyer.
1886..... J. D. Parker, N. S. Goss.
1887..... J. R. Mead, E. H. S. Bailey.
1888..... E. H. S. Bailey, T. H. Dinsmore, jr.
1889..... E. H. S. Bailey, G. H. Failyer.
1890..... D. S. Kelly, F. W. Cragin.
1891..... F. W. Cragin, O. C. Charlton.
1892..... F. O. Marvin, Mrs. N. S. Kedzie.
1893..... J. T. Willard, E. B. Knerr.
1894..... I. D. Graham, J. D. Hewitt.
1895..... I. D. Graham, S. W. Williston.
1896..... S. W. Williston, D. E. Lantz.
1897..... D. E. Lantz, A. S. Hitchcock.
1898..... C. S. Parmenter, L. C. Wooster.
1899..... A. S. Hitchcock, J. R. Mead.
1900..... E. Miller, J. C. Cooper.
1901..... J. C. Cooper, L. C. Wooster.
1902..... Edward Bartow. J. A. Yates.
1903..... Edward Bartow, J. A. Yates.
1904..... L. C. Wooster, B. F. Eyer.
1905..... W. A. Harshbarger, F. W. Bushong.
1906..... B. F. Eyer, J. E. Welin.

SECRETARIES.

1869-'73.. J. D. Parker.
1874, '75.. John Wherrell.
1876, '77.. Joseph Savage.
1878-'89.. E. A. Popenoe.
1890-'92.. E. H. S. Bailey.
1893..... A. M. Collette.
1894-'98.. E. B. Knerr.
1899-'01.. D. E. Lantz.
1902-'04.. G. P. Grimsley.
1905..... J. T. Lovewell.

TREASURERS.

1869-'73.. F. H. Snow.
1873-'75.. R. J. Brown.
1876, '77.. W. K. Kedzie.
1878-'83.. R. J. Brown.
1884, '85.. A. H. Thompson.
1886-'90.. I. D. Graham.
1891..... F. O. Marvin.
1892-'95.. D. S. Kelly.
1896..... L. E. Sayre.
1897-'00.. J. W. Beede.
1901, '02.. E. C. Franklin.
1903-'05.. Alva J. Smith.

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2-3-1932

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MEMBERSHIP OF THE ACADEMY,

January 10, 1906.

HONORARY MEMBERS.

G. P. Grimsley, Ph. D., 1904, assistant state geologist, Morgantown, W. Va.
Rev. Johns D. Parker, 1897..... New Haven, Conn.
Arnold B. Johnson, 1897, U. S. Lighthouse Board.... Washington, D. C.
W. A. Kellerman, Ph. D., 1897, Ohio State University, Columbus, Ohio.
Edw. L. Nichols, Ph. D., 1897, Cornell University.... Ithaca, N. Y.
W. S. Franklin, Sc. D., 1897, Lehigh University..... South Bethlehem, Pa.
Geo. Wagner, Phar. C., 1904, University of Wisconsin, Madison, Wis.
S. W. Williston, Ph. D., 1902, University of Chicago, Chicago, Ill.

ASSOCIATE MEMBERS.

Mrs. R. J. Brown, 1903..... Leavenworth.
Mrs. Mary Savage, 1897..... Lawrence.

LIFE MEMBERS.

Dates printed in the following list signify date of election to membership in the Academy.

E. H. S. Bailey, Ph. D., 1883, University of Kansas.. Lawrence.
F. W. Cragin, M. S., 1880..... Colorado Springs.
L. L. Dyche, M. S., 1881, University of Kansas..... Lawrence.
Geo. H. Failyer, Ph. D., 1879, Department of Agr.... Washington, D. C.
E. C. Franklin, Ph. D., 1884, Leland Stanford Jr. Univ., Stanford Univ., Cal.
I. D. Graham, 1879, *Kansas Farmer*..... Topeka.
Erasmus Haworth, Ph. D., 1882, University of Kansas, Lawrence.
Warren Knaus, M. S., editor McPherson *Democrat*... McPherson.
D. E. Lantz, M. S., 1887, Biological Survey..... Washington, D. C.
J. T. Lovewell, Ph. D., 1878, secretary Ac. of Sci.... Topeka.
F. O. Marvin, C. E., 1884, University of Kansas..... Lawrence.
J. R. Mead, 1879..... Wichita.
Ephraim Miller, Ph. D., 1873, University of Kansas.. Lawrence.
E. A. Popenoe, A. M., 1872, Kansas Agr. College.... Manhattan.
L. E. Sayre, Ph. M., 1885, University of Kansas..... Lawrence.
Alva J. Smith, 1903, county surveyor..... Emporia.
B. B. Smyth, 1880, curator Goss ornith. collection.... Topeka.
F. H. Snow, Ph. D., 1868, University of Kansas..... Lawrence.
A. H. Thompson, D. D. S., 1873..... Topeka.
D. M. Valentine, LL. D., 1878..... Topeka.
M. L. Ward, D. D., 1880, Ottawa University..... Ottawa.
J. T. Willard, M. S., 1883, Kansas Agr. College..... Manhattan.
S. W. Williston, Ph. D., 1880, University of Chicago, Chicago, Ill.

ANNUAL MEMBERS.

L. O. Adams, 1903, University of Kansas..... Lawrence.
Orr Adams, 1898..... Telluride, Colo.
Frank G. Agrelius, 1905..... Lawrence.
H. C. Allen, 1904..... McPherson.
Carroll D. Armstrong, M. D., 1905..... Salina.
John J. Arthur, 1904..... Topeka.
W. R. Arthur, 1903, A. B., high school..... Logan.
C. H. Ashton, 1903, University of Kansas..... Lawrence.
Alfred W. Ayers, 1904, minister Cong. church..... Onaga.
Harvey W. Baker, 1902, Kansas Agricultural College, Manhattan.
M. A. Barber, 1904, University of Kansas ..... Lawrence.
Elam Bartholomew, M. S., 1895..... Stockton.
Edward Bartow, Ph. D., 1897, University of Kansas.. Lawrence.
Wm. C. Bauer, A. M., 1897, Baker University..... Baldwin.
W. J. Baumgartner, 1904, University of Kansas ..... Lawrence.
Frank G. Bedell, 1904..... Iola.
J. W. Beede, Ph. D., 1894, University of Indiana.... Bloomington, Ind.
Edw. Bumgardner, M. D., 1896..... Lawrence.
F. W. Bushong, B. S., 1896, Kansas City University, Kansas City, Kan.
H. P. Cady, 1904, University of Kansas..... Lawrence.
M. E. Canty, 1903 ..... Buffalo.
Chas. I. Corp, 1905, University of Kansas..... Lawrence.
Clarence L. Cole, M. D., 1902..... Washington, D. C.
Ewing N. Collett, 1903, Indian University..... Bacone, I. T.
Rev. John T. Copley, 1903 ..... Clinton.
J. C. Cooper, 1899..... Topeka.
R. W. Coppedge, 1905, high school..... Topeka.
E. G. Corwine, 1905, student ..... Mulvane.
W. R. Crane, 1904, University of Kansas ..... Lawrence.
Ralph K. Crawford, 1904, University of Kansas..... Lawrence.
F. F. Crevecœur, 1899..... Onaga.
Robert W. Curtis, Ph. D., 1904, University of Kansas, Lawrence.
F. B. Dains, Ph. D., 1902, Washburn College ..... Topeka.
R. E. Davis, 1904..... Fort Scott.
Geo. A. Dean, 1903, Kansas Agricultural College..... Manhattan.
Emil O. Deere, 1905, Bethany College..... Lindsborg.
S. D. Dice, 1904, public schools ..... Alma.
James Dickson, 1904, University of Kansas ..... Lawrence.
Hugo Diemer, M. E., 1903, University of Kansas .... Lawrence.
R. B. Dunlevy, B. S., 1896, Southwest Kansas College, Winfield.
E. X. H. Dunmire, 1905, University of Kansas..... Lawrence.
Harry Eagle, 1905, student ..... Topeka.
J. Whit Ebey, 1903, science teacher..... Howard.
H. W. Emerson, 1904, University of Kansas ..... Lawrence.
H. W. Ewing, D. D. S., 1903, Iola Gas Company..... Iola.
B. F. Eyer, B. S., 1894, Kansas Agricultural College, Manhattan.
Fred Faragher, 1904..... Lawrence.
Thos. B. Ford, 1905, University of Kansas..... Lawrence.
Lillian E. Fowler, 1905, Ottawa high school..... Ottawa.

ANNUAL MEMBERS.

A. O. Garrett, 1901, high school..... Salt Lake City, Utah.
Chas. N. Gould, B. S., 1903, University of Oklahoma, Norman, Okla.
C. F. Gustafson, 1899, Kansas City high school..... Kansas City, Mo.
Brice E. Hammers, 1904, chemist Santa Fe shops.... Topeka.
J. O. Hamilton, 1903, Kansas Agricultural College.... Manhattan.
Dr. Eva Harding, 1904..... Topeka.
H. J. Harnly, B. S., 1893, McPherson College..... McPherson.
W. A. Harshbarger, B. S., 1902, Washburn College... Topeka.
Frank Hartman, 1905, student..... Kansas City, Kan.
L. D. Havenhill, 1904, University of Kansas..... Lawrence.
H. D. Hess, 1904, University of Kansas..... Lawrence.
W. E. Henderson, 1901..... Iola.
Francis C. Herr, 1905, physician..... Ottawa.
W. C. Hoad, 1904, University of Kansas..... Lawrence.
Geo. J. Hood, 1904, University of Kansas..... Lawrence.
Geo. H. Hoxie, M. D., 1902, University of Kansas... Lawrence.
W. F. Hoyt, A. M., 1902, Kansas Wesleyan University, Salina.
L. C. Hodson, 1905, University of Kansas..... Lawrence.
B. C. Hubbell, 1905..... Concordia.
Albert K. Hubbard, 1904, University of Kansas..... Lawrence.
Thos. M. Iden, 1897, State Normal School..... Emporia.
F. B. Isely, B. S., 1902, high school..... Wichita.
John J. Jewett, 1902..... Sawtelle, Cal.
Carl Johns, 1900, Bethany College..... Lindsborg.
A. W. Jones, B. S., 1894, Kansas Wesleyan University.. Salina.
Hugo Kahl, 1897, Carnegie Museum..... Pittsburg, Pa.
George F. Kay, 1904, State University..... Lawrence.
W. H. Keller, 1898, Atchison county high school..... Effingham.
Harry L. Kent, 1904, high school..... Hays City.
John H. Klopfer, 1904..... Topeka.
E. B. Knerr, Sc. D., 1889..... Atchison.
Rev. James G. Knotter, 1903..... Dexter.
Pierce Larkin, 1902, University of Oklahoma..... Norman, Okla.
B. E. Lewis, 1904, city schools..... Eureka.
C. H. Lyon, 1900, high school..... Emporia.
Hester E. Loveall, 1904..... Fort Scott.
H. T. Martin, 1902, University of Kansas..... Lawrence.
R. Matthews, D. D. S., 1898..... Wichita.
Walter E. Matthewson, 1903, Kansas Agr. College... Manhattan.
F. M. McClenahan, 1903, Kansas Agricultural College.. Manhattan.
C. E. McClung, 1903, University of Kansas..... Lawrence.
Elmer V. McCollum, 1902, University of Kansas..... Lawrence.
Edith A. McIntyre, B. S., 1902..... Middletown, N. Y.
D. F. McFarland, 1903, University of Kansas..... Lawrence.
J. M. McWharf, M. D., 1902..... Ottawa.
W. G. Medcraft, 1904, Kansas Wesleyan University.. Salina.
Grace R. Meeker, 1899..... Ottawa.
C. F. Menninger, M. D., 1903..... Topeka.
H. L. Miller, 1904, high school..... Topeka.

ANNUAL MEMBERS.

Roy L. Moodie, 1904, University of Kansas..... Lawrence.
L. N. Morscher, 1900, high school..... Lawrence.
Travis Morse, 1903..... Iola.
J. H. Newby, 1899, photographer..... Osage City.
A. M. Nissen, A. M., 1888, high school..... Wetmore.
Henry N. Olson, 1905, Bethany College..... Lindsborg.
D. H. Otis, M. S., 1897..... Madison, Wis.
W. K. Palmer, M. E., 1897, consulting engineer..... Kansas City, Mo.
Frank Patrick, 1903..... Topeka.
Leslie F. Paull, 1903, manual-training school..... Kansas City, Mo.
L. M. Peace, 1904, University of Kansas..... Lawrence.
Norman Plass, D.D.,1902, president Washburn College, Topeka.
S. F. Poole, B. S., 1902, Fairmount College..... Wichita.
Charles H. Popenoe, 1903, Kansas Agricultural College, Manhattan.
J. M. Price, A. M., 1900..... Atchison.
C. S. Prosser, M. S., 1892, Ohio State University.... Columbus, Ohio.
W. S. Prout, 1904..... Topeka.
Albert B. Reagan, 1904, Indian school..... Rosebud, S. Dak.
W. F. Rice, 1902, public schools..... Gordon.
W. B. Robertson, 1905, student..... Lawrence.
A. P. Ruediger, 1905..... Lawrence.
Lumina C. Riddle, M. S., 1902..... Columbus, Ohio.
Arthur Ringer, 1902, Atchison county high school..... Effingham.
W. G. Russell, 1905..... Russell.
Richard Scammon, 1905, student..... Lawrence.
D. C. Schaffner, 1903, College of Emporia..... Emporia.
J.H.Schaffner, A.M.,M.S.,1902, Ohio State University, Columbus, Ohio.
Theo. H. Scheffer, 1903, Kansas Agricultural College, Manhattan.
Eva Schley, 1903, high school..... Topeka.
Aaron Schuyler, 1904, Kansas Wesleyan University... Salina.
C. H. Shattuck, 1899, Washburn College..... Topeka.
Roscoe H. Shaw, 1904, University of Nebraska..... Lincoln, Neb.
J. L. Shearer, 1902, public schools..... Halstead.
E. T. Shelley, M. D., 1892..... Atchison.
R. S. Sherwin, 1904..... Norman, Okla.
Claude J. Shirk, 1905, teacher of science..... McPherson.
J. A. G. Shirk, 1904, University of Kansas..... Lawrence.
Paul L. Shuey, 1905, University of Kansas..... Lawrence.
Ralph C. Shuey, 1905, University of Kansas..... Lawrence.
Eugene G. Smyth, 1901..... Topeka.
Wesley N. Speckman, Ph. D., 1903, Kan. Wesl. Univ., Salina.
B. T. Stauber, D. D., 1903..... Salina.
S. G. Stewart, M. D., 1904..... Topeka.
Chas. M. Sterling, 1904, University of Kansas..... Lawrence.
Chas. H. Sternberg, 1895..... Lawrence.
Teresa Stevenson, 1901..... Ottawa.
W. C. Stevens, 1904, University of Kansas..... Lawrence.
E. F. Stimpson, University of Kansas..... Lawrence.
A. J. Stout, 1904, high school..... Topeka.

ANNUAL MEMBERS.

R. S. Sherwin, 1901 ..... Norman, Okla.
Frank Strong, 1905, chancellor of University ..... Lawrence.
Olin Templin, 1904..... Lawrence.
A. M. Ten Eyck, 1903, Kansas Agricultural College.. Manhattan.
F. J. Titt, B. S., 1898, Kingfisher College..... Kingfisher, Okla.
Norman Triplett, 1905, State Normal School ..... Emporia.
E. S. Tucker, 1904, University of Kansas..... Lawrence.
P. F. Walker, 1905, University of Kansas..... Lawrence.
J. D. Walters, M. S., 1894, Kansas Agr. College.... Manhattan.
Howard R. Watkins, 1905, Kansas Agr. College..... Manhattan.
C. D. Weaver, M. D., 1902 ..... McPherson.
Ella Weeks, 1903, Kansas Agricultural College..... Manhattan.
J. E. Welin, 1899, Bethany College ..... Lindsborg.
W. B. Wilson, 1903, Ottawa University..... Ottawa.
E. M. Williams, 1904 ..... Chicago, Ill.
L. B. Wishard, 1903, high school..... Iola.
C. H. Withington, 1903, Kansas Agricultural College, Manhattan.
Heman A. Wood, 1905, Kansas Agricultural College.. Manhattan.
H. I. Woods, M. S., 1902, Washburn College..... Topeka.
L. C. Wooster, 1897, State Normal School ..... Emporia.
J. A. Yates, M. S., 1898, Ottawa University..... Ottawa.

Total number of members, January 10, 1906, 204.

SECRETARY'S REPORT, 1905.

THE present secretary began his duties about the 10th of January. At that time the nineteenth volume of the Transactions was in the hands of the state printer, and one of the first tasks devolved on the new secretary was to see that the promises of an early issue of the forthcoming volume were duly fulfilled. It soon became apparent that the state printer was not bound by an understanding he had with Professor Grimsley, either because the latter did not make the plan sufficiently definite, or because the former had a change of heart after it was settled that he would go out of office in June. At any rate we could not get the extra copies of papers which the Academy had voted, and the best that could be done was to have fifty extra copies of each signature of the Transactions printed. These were divided up and sent to the authors as a partial remedy for the failure.

The rush of legislative printing delayed the completion of our volume till May, and it was gratifying to note, when it did come out, that it was the largest and one of the best yet sent forth by the Academy.

The Transactions were distributed according to vote of the Academy, giving to each member a copy, and an extra copy was sent to writers of papers.

The usual distribution to exchanges was made, and copies sent to state officials and to prominent newspapers. Members of the legislature were supplied on application, but other applicants had to be informed that our Transactions were on sale at list prices.

The exchange list is much as it has been for some years, and it may be very profitably revised and enlarged. It is through this that our library obtains its growth, and will become, if properly managed, a very unique and valuable collection of books.

THE MUSEUM.

While the last legislature was in session, an invitation was sent out by the secretary for members and others to visit the museum, then just installed in its permanent quarters.

It is believed that this had a favorable influence in making known the work of the Academy and in securing legislative provision for its support. We are by law a "coordinate department

of the State Board of Agriculture," and there is no doubt we shall receive all the recognition we deserve. We have a field of activity of our own, which supplements the agricultural, the educational, the mechanical and the commercial work of the state, and it is for us to take possession of our province.

In its enlargement our museum has happily taken the form of an exhibit of the economic mineral resources of the state, and this, with proper care and growth, may become one of the most interesting and useful collections in the state-house. Our present display is the outcome of the Louisiana Purchase Exposition, at St. Louis, and the near approach of the commemoration of the semicentennial of Kansas is an opportunity this Academy should not neglect of strengthening itself and doing its share in the upbuilding of our commonwealth. It will be very appropriate at this meeting for the Academy to put itself on record as a promoter of this worthy enterprise. The mineral resources of Kansas are only beginning to be known, and promise to add to our wealth an equal quota with the agricultural products. The total value of our coal, of our petroleum, our clays, cements, and plaster, of our salt, of our glass sand, and many other minerals, represents a fortune, compared with which the wealth of a modern Crœsus appears insignificant.

LIBRARY.

Reference has already been made to our books, and in considering a library, its quality is quite as important as its size. We are constantly receiving the transactions of scientific bodies from various parts of the earth. We also get various government publications from Washington, and have had each year, for some time, several hundred volumes of these publications neatly bound. Our catalogue at this date gives only the titles of these volumes, grouped under names of the countries from which they come. We need very much a catalogue arranged according to modern library methods, which will make it possible to use conveniently the many valuable books in our collection. All the leading European languages are represented, and your secretary will need clerical assistance to bring the library into proper shape.

We have been loaning books to members with much advantage, no doubt, but this practice requires some rules as to the time such loaned books may be kept, or the library will suffer loss. I recommend a committee to formulate such rules as may seem best to govern the loaning of books.

The Transactions are the chief asset of the library, and owing to

irregularities in the number published of each volume, it has come to pass that we can no longer furnish complete sets. A few years ago a reprint was made of the first three volumes, and now a similar reprint is needed of volumes IV, V, VI, and VII. With this provision we can furnish as many as 100 complete sets of our Transactions, and with these can secure valuable exchanges for our library.

The committee on purchase of books has not yet reported to me any action, although their attention has been called to it several times. The money now in the treasury would go far toward paying for reprints of the four volumes mentioned above, and they would be equivalent to a library fund that will in time bring back to the treasury several times the sum invested.

The State Printing Board honored our requisition for binding 500 volumes, and about one-half that number are now completed and on our shelves.

ACCESSIONS.

There have been added to the library, since January 10, 1905, 70 bound volumes and about 600 unbound volumes and pamphlets. These are outside of our regular exchanges, and the bound volumes are mainly from the Smithsonian Institution and other departments at Washington.

The geological and agricultural bureaus are especially prolific, and some of their publications are of great value. We obtain, also, many costly publications from St. Petersburg, and it would be convenient for helping reference to such books to have on our tables lexicons of the languages in which our books are printed.

J. T. LOVEWELL, *Secretary.*

DECEMBER 1, 1905.

MINUTES.

Thirty-eighth Annual Meeting, Kansas Academy of Science, December 1 and 2, 1905.

LAWRENCE, KAN., December 1, 1905.

PURSUANT to call of the executive committee, the thirty-eighth meeting of the Kansas Academy of Science was opened in the lecture-room of Snow hall at nine A. M., with the president, L. C. Wooster, in the chair. There was an attendance of about fifty members, and the president announced the following committees:

On resolutions: Messrs. Mead, Willard, and Miss Meeker.

On necrology: Messrs. Knaus, Miller, and Cooper.

On membership: Messrs. Bushong, Tucker, and Harshbarger.

On nominations: Messrs. Stevens, Scheffer, and Iden.

On the press: Messrs. Sayre and Knaus.

The secretary's report was read and accepted. On motion, certain recommendations of this report were referred to a committee, and the chair named Messrs. Willard and Bushong as this committee.

The Academy next listened to the reading of papers in the following order:

1. A new repetition of the Foucault pendulum experiment, J. T. Lovewell.
2. The genesis of gold in mineral veins and placers, J. T. Lovewell.
3. Some recent high-efficiency lamps, L. H. Freeman.
4. Is the rainfall of Kansas increasing? F. H. Snow.
5. The University of Kansas expedition into the John Day region of Oregon, C. E. McClung.

Professor Sayre, on behalf of the local committee, announced that the afternoon meetings of the Academy would be in two sections, which is necessary in order to complete the reading of the papers that are on the program.

President Wooster ruled that the vice-presidents will be chairmen at these meetings of the sections, which will be designated as section A and section B, respectively.

Reading of papers resumed.

6. The variation of latitude, E. Miller.

7. Examination of coal-dust after explosion in mines (read by title, in absence of author), E. Bartow.

The committee on nomination, reported the following names for membership:

Frank G. Agrelius, teacher	Lawrence.
Carol D. Armstrong, M. D.	Salina.
Charles I. Corp, University of Kansas	Lawrence.
E. G. Corwine, student	Mulvane.
Emil O. Deere, Bethany College	Lindsborg.
E. X. H. Dunmire, University of Kansas	Lawrence.
Harry Eagle, student	Topeka.
Thomas B. Ford, University of Kansas	Lawrence.
Frank Hartman, student	Kansas City, Kan.
Francis C. Herr, physician	Ottawa.
R. W. Coppedge, high school	Topeka.
Lillian E. Fowler, Ottawa University	Ottawa.
L. C. Hodson, University of Kansas	Lawrence.
B. C. Hubbell, secretary Casine Soap Company	Concordia.
C. H. Lyon, high school	Emporia.
Henry N. Olson, Bethany College	Lindsborg.
W. B. Robertson, student	Lawrence.
A. P. Ruediger	Lawrence.
Richard Scammon, student	Lawrence.
Claude J. Shirk, teacher	McPherson.
Paul L. Shuey, University of Kansas	Lawrence.
Ralph C. Shuey, University of Kansas	Lawrence.
Frank Strong, chancellor of University	Lawrence.
Norman Triplett, State Normal School	Emporia.
P. F. Walker, University of Kansas	Lawrence.
Howard R. Watkins, Kansas Agricultural College,	Manhattan.
Heman A. Wood, Kansas Agricultural College	Manhattan.

On motion, the vote of the Academy was cast by the secretary for the election as members of the persons named in the report.

Adjourned, to meet in sections at two o'clock P. M.

SECTION A.

F. W. Bushong, president; L. E. Sayre, secretary.

8. The disintegration of cement and plaster walls, E. H. S. Bailey and S. G. Stromquist.

9. The fluorescence of a solution of quinine salts, H. P. Cady.

10. Some properties of the alloys of the ferro-magnetic metals, considered from the standpoint of Osmond's allotropic theory, Bruce V. Hill.

11. Kansas petroleum (third article, read by title), E. Bartow.

12. Something about mineralogy, J. C. Cooper.

13. Note on certain formulas for the design of reenforced concrete beams, Albert K. Hubbard.

14. On the substituted ureas, F. B. Dains.

15. Chemical processes for the detection of adulterants in organic substances and medicinal chemicals, L. E. Sayre.

16. An investigation of Kansas mine water (by title), E. H. S. Bailey.

17. Chemical reactions in benzene (by title), H. C. Allen.

SECTION B.

W. A. Harshbarger, president; D. F. McFarland, secretary.

18. A chemical study of the lime and sulfur dip, Roscoe H. Shaw.

19. The Loup Fork Miocene of northwestern Kansas, Charles H. Sternberg.

20. The reaction of animal cells to chemical stimuli, F. H. Hartman.

21. Test for cyanide (read by title), H. P. Cady.

22. Note on use of mercurous sulfate in standard cells (by title), H. P. Cady.

23. A mineral found in Topeka, J. T. Lovewell.

24. Additional observations on the geology of Kansas, L. C. Wooster.

25. Notes on Coleoptera, W. Knaus.

26. Some mastodon and mammoth remains found in Buffalo, Kan., M. E. Canty.

27. Notes on the flora of the Rosebud Indian reservation, South Dakota (by title), Albert B. Reagan.

28. Hygroscopic structures in the distribution of pollen grains and spores (illustrated), M. A. Barber.

29. Secondary increase in thickness of smilax (illustrated), W. C. Stevens.

30. Nutrition of developing spores in ferns (illustrated), W. C. Stevens.

31. Dry periods in northeastern Kansas and the relation to water-supplies, W. C. Hoad.

32. Collecting insects at night, E. S. Tucker.

33. Transpiration in plants, L. M. Peace.

34. *Melilotus alba* (white clover) (by title), R. W. Coppedge.

35. On Coleoptera of New Mexico—III, W. Knaus.

36. Notes on Cicindelidæ—II, Eugene G. Smyth.

Section adjourned at five o'clock.

At six o'clock the Academy met in the large assembly-room of Snow hall, where a most delightful banquet had been prepared by the faculty of the University, and soon about seventy-five mem-

bers were seated at the long table, and Professor Bailey acted as master of ceremonies.

After justice had been done to the bountiful repast, and toasts were responded by Messrs. Snow, Sayre, Willard, Strong, Lovewell, Mead, Cooper, Miller, Knaus, and others, it was time to go to the lecture-room and resume the

GENERAL SESSION.

The first order was to listen to President Wooster's retiring address. The theme chosen was "The Development of the Sciences in Kansas."

After this address, which was heard with interest, the Academy adjourned, to meet to-morrow at nine o'clock.

GENERAL SESSION, SATURDAY, DECEMBER 2, 1905.

The committee on nominations reported their action as follows:

For president, F. O. Marvin, Lawrence.

First vice-president, B. F. Eyer, Manhattan.

Second vice-president, J. E. Welin, Lindsborg.

Treasurer, Alva J. Smith, Emporia.

Secretary, J. T. Lovewell, Topeka.

On motion of Professor Miller, the rules were suspended, and the president directed to cast the vote of the entire Academy for the candidates named.

On motion, the Academy separated again into sections and proceeded with the reading and discussion of papers.

SECTION A.

37. Natural gas in Lawrence, H. W. Emerson.

38. The Red phalarope, a new bird for Kansas, L. L. Dyche.

39. A simple method of finding the line of intersection of pyramids and prisms, Chas. I. Corp.

40. The interpretation of indicator diagrams, Chas. I. Corp.

41. A description of Huesler's magnetic alloys of manganese, copper, and aluminum, Bruce V. Hill.

42. A good rock exposure west of Topeka, Wm. S. Prout.

43. A bit of engineering at Mount Vernon (by title), M. L. Ward.

44. Results of the entomological collecting expedition of the University of Kansas to Brownsville, Tex., F. H. Snow.

45. Results of the entomological expedition to southeast Arizona, F. H. Snow.

46. A revised catalogue of the Lepidoptera of Kansas, F. H. Snow.

47. Noise; its relation to health disease, and longevity, J. M. McWharf.

48. History of oil and natural gas development in the middle West (by title), George P. Grimsley.

SECTION B.

49. On Haliptidæ, Dytiscidæ, Gyrinidæ, Hydrophilidæ, Sylphidæ, Elasticidæ and Ptinidæ of Kansas, W. Knaus.

50. On the malaria musquito and the relative number present in the vicinity of Lawrence, S. J. Hunter.

51. Catalogue of the Goss ornithological collection, with original notes and measurements by Col. N. S. Goss (by title), prepared by B. B. Smyth, curator.

52. Comparison of the microscopical structure of stems and roots, C. M. Sterling.

53. Additions to the list of Kansas Coleoptera for 1905, W. Knaus.

54. Notes on the white sheep, L. L. Dyche.

55. A little experiment in flower-making, Grace Meeker.

56. The gas- and oil-engine for commercial purposes, P. F. Walker.

57. A deep well at Emporia, Alva J. Smith.

58. Additions to list of Kansas arachnids, Theo. H. Scheffer.

59. Additions to the list of Kansas Diptera, F. F. Crevecœur.

60. The botanical features of the new United States Pharmacopœia, L. E. Sayre.

61. A revised catalogue of the Lepidoptera of Kansas, F. H. Snow.

The committee on necrology reported that no death of any member during the past year had been brought to their notice.

Professor Bailey and others called attention to the need of a publication committee, who should decide which of the papers read during the session should be printed in the Transactions.

The matter was left in the hands of the executive committee to appoint such a board of critics.

Professor Sayre announced that special privileges would be granted to members of the Academy in visiting the exhibition of Tissot paintings.

The committee on resolutions reported as follows:

The thirty-sixth annual session of the Kansas Academy of Science, now drawing to the close of a most profitable meeting, finds reason for congratulating itself upon the zeal of its members in gaining accessions to the membership list, as well as in the number of papers offered, showing the work in science during the year.

The Academy wishes to record its appreciation of the work done by its officers in arranging for and conducting the various meetings. Especial thanks are due the committee for the rearrangement of the program into sections, and for furnishing to the members appropriate badges.

Our thanks are due to Professor Griffith for special courtesy, making it possible for the members to enjoy the Tissot pictures.

To the members of the Academy in Lawrence, whose guests we have been, we offer hearty thanks for the generous hospitality shown us and our friends, which will make another in the series of "red-letter days" to add to the memories of former years in meetings of the Academy.

J. R. MEAD,
J. T. WILLARD,
GRACE MEEKER,
Committee.

The committee to whom was referred the secretary's report recommend:

1. That in books borrowed from the Academy library, the time limit during which a book may be retained be one month, and that it be the duty of the secretary to notify the holder of the expiration of the time.

2. That volumes IV, V, VI and VII be reprinted as soon as the funds of the Academy permit, and that the matter be referred to the executive committee for action.

3. That we give our hearty indorsement to the project of celebrating the semicentennial of the state in 1911.

J. T. WILLARD,
F. W. BUSHONG,
Committee.

TREASURER'S REPORT.

The treasurer reported as follows:

Balance on hand from last year	$321 23
Receipts since, prior to this meeting	159 00

The treasurer's books were audited and found correct.

On motion of Professor Sayre, the treasurer was directed to make a time deposit to the amount of $250.

The receipts from this meeting are not included in the above report.

The business being completed, the Academy adjourned, to meet at the call of the executive committee.

J. T. LOVEWELL, *Secretary.*

DECEMBER 2, 1905.

PRESIDENT'S ADDRESS AND PAPERS READ

BEFORE THE

KANSAS ACADEMY OF SCIENCE,

AT

LAWRENCE, 1905.

I.—President's Address.
II.—Chemical Papers.
III.—Geological Papers.
IV.—Biological Papers.
V.—Botanical Papers.
VI.—Mathematical and Physical Papers.
VII.—Miscellaneous Papers.
VIII.—Announcements, etc.

I.

PRESIDENT'S ADDRESS.

"THE DEVELOPMENT OF THE SCIENCES IN KANSAS."

By LYMAN C. WOOSTER, Ph. D., State Normal School, Emporia.

THE DEVELOPMENT OF THE SCIENCES IN KANSAS.

By LYMAN C. WOOSTER, Ph. D., Emporia.

Presidential address, delivered at Lawrence, December 1, 1905, before the thirty-eighth annual meeting of the Kansas Academy of Science.

IN preparing this address, the speaker has kept constantly in mind the needs and special interests of those who are beginners in scientific work or are actively engaged in exploring fields that are new and difficult. More than thirty years of science work in the schoolroom have fostered within him a most earnest desire to help in all scientific enterprises.

The membership of our Academy of Science has been nearly doubled during the past few years by reason of somewhat urgent efforts on the part of its officers and members. Similar efforts made during the past thirty-seven years of the existence of our organization have been attended with equal success, and so, undoubtedly, like efforts will be made during the future years of its existence.

Why should we attempt to increase the attendance at our meetings? Some of the answers that might be given would undoubtedly be the following:

1. All people should be in some degree naturalists, for they will thus have their hours of happiness largely increased.

2. The state needs more naturalists and scientists, for her industries must always be largely agricultural, horticultural and mining in their character, and the prosperity of farmers, miners and orchardists is in large measure dependent on our knowledge of minerals and of plant and animal friends and foes.

3. The schools of the state are giving a large place each year to nature studies and to natural-science subjects, and the teachers in the public schools must be more largely naturalists and scientists if they do this work successfully.

4. The pupils in the public schools need manuals containing serviceable keys of Kansas plants; Kansas insects; Kansas fish, amphibians, reptiles, birds, and mammals; Kansas crustaceans, mollusks, worms, hydra, sponges, and Protozoa; and Kansas fossils and minerals. These keys and natural histories should be prepared by Kansas naturalists and scientists under the auspices of this Acad-

emy or some similar organization containing men and women of large and varied experience in many fields of natural history.

5. A large membership gives the Academy a larger influence throughout the state and with the members of the state legislature. We are sadly in need of such recognition of the worth of our reports and of our library and museum, that abundant appropriations may be easily forthcoming.

6. The attendance at common meeting-places at stated times of large numbers of men of science would enable the Academy so to divide its work as to make it possible for those engaged in similar lines of investigation to meet in sections, and thus enable naturalists, scientists and philosophers to learn by personal conference what is being done in related lines of research.

7. With many contributors to their pages, the Academy could issue more valuable volumes of proceedings and a series of monographs on special subjects.

These seven reasons why we should continue to work for a larger membership to the Academy could easily be extended to several more, but those named will serve as an introduction to what it is desired to present for the favorable consideration of this audience. It is not intended to discuss the propositions embodied in the reasons just given in the order in which they have been presented, but an effort will be made to discuss them as they find place in the orderly unfolding of the subject of this address: The Development of the Sciences in Kansas.

On September 1, 1868, a number of lovers of nature gathered at what is now Washburn College and organized themselves into the Kansas Natural History Society. The name was well chosen, for its members were truly naturalists, and as such have done work of the highest value for themselves and the state.

If those of our members who have made collections of natural-history specimens and data will remember the experiences of collecting trips, or those attending investigations in the laboratory, they must declare that this work has brought more hours of happiness than almost any other that has engaged both hands and minds.

The speaker's own most persistent work as a naturalist has been done in collecting fossils, though insects, birds and plants have been collected with almost equal pleasure.

There is great delight in going through one's collections to feast one's eyes on some rare forms possessed by few others. Each time the hand rests on the specimen there is experienced anew the wild delight that was present when there was first found a specimen of

Eurypterus pachychirus, *Petalodus alleghaniensis*, or *Hydreionocrinus kansasensis*. Each detail of each great find is indelibly stamped on the memory. The only moments of regret come when it is remembered how the unfortunate individual who has been so indiscreet as to ask about the collections has been bored as the rare things have been brought out, their possessor forgetting that the poor victim knew little or nothing of what he was pleased to show him, and that he cared even less.

As a teacher of the sciences anxious to discover the best ways of presenting the subjects that belong to his department, the speaker has asked himself and others, Why do naturalists value their collections so highly, and why were most scientists first naturalists?

A glance through the reports of this Academy would make one marvel at the amount of space taken by lists of species contributed by its members, were it not known by personal experience that naturalists prize their collections even more than they do the knowledge that this or that species of plant or animal is a friend or a foe to the farmer, orchardist, or gardener.

In the first volume of proceedings issued by this Academy there is found a catalogue of plants, by J. H. Carruth, with additions by F. H. Snow and E. Hall; a catalogue of birds, by F. H. Snow; and a collection of facts on the climate of Kansas, by F. H. Snow. The lists show that great care had been taken to make them as complete as possible. They occupy more than half of the space of the volume, and must have been very helpful to other naturalists. The succeeding eighteen volumes are almost equally rich in lists of species—in all, more than ninety different lists. Of these, flowering plants furnish nearly one-third of the list, and, in the order named, Coleoptera, birds, minerals, fossils, Lepidoptera and some twelve or thirteen other groups the remainder.

To these lists of species should be added numerous lists of facts of observation and experiment. These comprise numerous references to work done in chemistry, physics, meteorology, mathematics, field geology, astronomy, psychology, and philosophy.

To show still further the intense interest of naturalists in collecting, a few members of the Academy have been asked to give, for use in this address, the number of species represented in their private collections.

Mr. Warren Knaus, of McPherson, reports that he has collected or obtained by exchange, since 1880, 5512 species of Coleoptera, distributed among 38 families.

Prof. Alfred W. Jones, of Salina, says that during the past ten

years he has collected 250 species of fossil plants from the Dakota sandstone; 30 invertebrate fossils from the Mentor Beds, of which 8 were new to science; and 300 species of marine and fresh-water shells.

Mr. B. B. Smyth writes me that the state collections under his charge at Topeka contain the following numbers of species and specimens:

	Species.	*Specimens.*
Birds, Goss collection	768	1,680
Birds, state collection	313	412
Mammals	34	40
Fishes, Popenoe and Smyth	78	80
Reptiles, Popenoe and Smyth	33	42
Insects, Snow and Popenoe	889	3,713
Herbarium, Smyth	1,860	5,600
Conchological collection, Quintard and Smyth	640	5,250
Totals	4,310	16,817

Mr. F. F. Crevecœur, of Onaga, Kan., reports the following very interesting miscellaneous collection:

	Species.	*Specimens.*
Birds	150	150
Mammals	9	11
Snakes	4	12
Lizards	4	15
Frogs	4	6
Fishes	2	4
Fossils	46	150
Plants	350	500
Archæology	2	3
Birds' eggs	54	300
Crustacea	15	30
Arachnida	21	50
Neuroptera	38	70
Orthoptera	47	90
Diptera	137	275
Hemiptera	383	750
Hymenoptera	506	1,000
Lepidoptera	630	1,260
Coleoptera	4,100	9,450
Totals	6,502	14,126

Prof. Theo. H. Scheffer, of the State Agricultural College, Manhattan, one of our authorities on spiders, reports 160 species in our state, 4 or 8 species of daddy-long-legs, and 1 species of scorpion.

Our most inveterate collector of vertebrate fossils is Mr. Chas. H. Sternberg, of Lawrence. His more than thirty years of experience in digging and restoring skeletons is probably unequaled in the United States.

Largely while in company with Dr. F. H. Snow, the following collection of insects was made by Eugene Smyth, a young man only nineteen years old:

	Species.	*Specimens.*
Diptera	80	230
Hymenoptera	148	380
Neuroptera	28	90
Orthoptera	75	215
Lepidoptera	122	350
Hemiptera	84	208
Coleoptera	2,196	17,678
Totals	2,733	19,151

Prof. F. B. Isely, of the Wichita high school, has in his collection 127 species of Kansas Orthoptera, as well as quite a number of species representing the other orders of insects.

But the monumental work of Dr. F. H. Snow, the oldest in membership and the most persistent collector of this Academy, is probably without an equal in the entire western hemisphere, if not in the whole world, when we consider the personal character of this work. Of insects, Doctor Snow reports:

	Species.	*Specimens.*
Coleoptera	9,060	63,000
Lepidoptera	3,750	10,000
Hymenoptera	2,050	10,500
Diptera	3,340	28,000
Orthoptera	300	1,500
Neuroptera	200	1,000
Hemiptera	500	5,000
Kansas spiders	55	500
Myriapods	45	250
Miscellaneous	200	1,000
Totals	19,500	120,900
Collected in 1904–'05	1,500	50,000
Making a grand total of	21,000	170,900

The account of Doctor Snow's work as a naturalist is still incomplete, for, in addition to his collection of insects, should be counted his early work on plants, his collection of meteorites, his list of Kansas birds, his accumulation of data bearing on Kansas weather, and his boxes of fossils, that he has been too modest to enumerate.

It was the hope of the writer to be able to give several other lists of collections made by members of this Academy, but the data were not received in time for this paper.

Your speaker's own craze for collecting has led him to load his cabinets with fossils; and he is very proud of the fact that he has collected fossil invertebrates and vertebrates from Massachusetts

to California, and in every rock group from the Potsdam sandstone to the Tertiary—in all, 700 or 800 species of fossils and 200 or 300 species of rocks and minerals.

The search for natural-history specimens is but one of the many forms of the collecting activity. As the speaker observed in a paper read at the Manhattan meeting of this Academy, the love of collecting is well-nigh universal, and the usefulness of the thing collected has little influence with the collector. To get something some one else has not, or something that is handsomer than that possessed by another, is balm to the feelings, and is inherent in all life tendencies, whether of man or of the lower organisms.

Modern psychology teaches that the mainspring of the will lies in the feelings and emotions, and not in the intellect, as was once believed. We do what we desire, not what the intellect advises. The student of social ethics has long since learned that the feelings aroused by possession and by rivalry are most potent in determining conduct. This is explained by the scientist who has formulated theories concerning heredity, by affirming that the feelings aroused by possession and rivalry are racial in their character, and are, therefore, inherited, subconscious tendencies in the individual; and that this is why they are so powerful in determining what we shall or shall not do.

To illustrate the power of these subconscious tendencies over the individual who chances to be a naturalist or even a collector of mere curiosities, please try to imagine the correct answers to the following questions: Why should Doctor Horn pay fifty dollars for a single beetle? What was there about a tiger-beetle, the *Amblychila cylindriformis*, that was so valuable or interesting that the museums of Europe and America were anxious to pay Doctor Snow twenty-five dollars a head for them? What is there about a tropical butterfly that should cause collectors to pay $100 or $200 for a single specimen? And why should millions of dollars be invested in canceled postage-stamps by stamp collectors in Europe and America?

Those who have never made a collection, save of silver, gold or paper dollars, who have never turned their racial collecting tendencies in the direction of natural-history specimens, find it nearly impossible to understand why such work as that performed by Doctor Snow has such a powerful attraction for naturalists.

One summer Louis Agassiz, then at the height of his fame as a public lecturer and as professor of zoology at Harvard, spent several weeks collecting in Vermont. A gentleman wishing to see

him inquired of a farmer if he had seen Professor Agassiz that morning. The farmer looked up from his work in surprise, and told the gentleman that Louis Agassiz, the great naturalist, lived at Cambridge, Mass., and that he guessed he would have to go there to find him. "There are no strangers here," the farmer added, "except a crazy old Dutchman who is over in the field yonder catching butterflies and bugs." The thrifty collector of lucre felt no affinity for a "Dutchman" catching insects.

One's ability to appreciate the collections of another seems also to stand in direct ratio to his stock of general information.

Soon after the civil war General Custer led an exploring expedition to the Black Hills. On the invitation of the government, several eminent men of science accompanied the troops. As the Sioux Indians were then very hostile, and the men of science insisted on making side trips for the purpose of collecting natural-history specimens, each scientist was attended by a guard of six soldiers, much to the discomfort of the latter and the inconvenience of the former. One day the most persistent collector escaped from his guard of soldiers and wandered off into the hills, where he was quickly pounced upon by the Sioux. The Indians thrust their hands into his pockets and collecting bag for plunder, and were disgusted to find that they contained plants, fossils, lizards, and other material dear to the heart of a naturalist, but worthless trash to Indians, and were exceedingly puzzled to know what sort of man they had captured. While the savages were discussing the nature of their queer captive, the naturalist saw a rare butterfly, and, forgetful of everything else, started off on a run to effect its capture. He soon returned and proudly exhibited his prize to the Indians. This decided them, and the chief took him gently by the sleeve, led him to a distant ridge, and pointed the way to Custer's camp. The Indians had concluded that the naturalist was insane, and thus, according to their belief, was under the special care of the Great Spirit; otherwise he would have been put to death for invading their country.

The farmer thought that the naturalist was spending his time foolishly; the Indians believed that he was crazy; and it is not sure but that each one of us thinks that the other naturalists would show better sense by collecting our specialty.

I have dwelt thus fully on the deep, unreasoning love with which a collector regards the specimens in his own cabinet, in part to make plain the cause of certain serious mistakes made by naturalists in publishing, as interesting matter to the world in general, the results of

their labors, mistakes which have been repeated by too many science teachers in the classroom.

Lists of plants, insects, and other invertebrates, fish, amphibians, reptiles, birds, and mammals, and detailed sections of geological strata, with lists of the included fossils, are of most interest and value to the one who made the list or section, are of some value to a few specialists, and are of no interest or value to the general reader. In the classroom their value is the same as that of the algebraic quantity, x.

Tons of scientific reports are gathering dust in private and public libraries because 99 readers out of 100 care nothing for them. Lists of species of plants, shells, insects, vertebrates, fossils and minerals are seldom read save by those who desire to make exchanges and who are enthusiastic collectors.

Editors of periodicals intended for the general reader have learned by severe experience what matter pleases their patrons best. I quote the following from an advertising circular issued by the New York *Independent:* "There is a prevalent belief among editors that the average reader hates science and will turn against any journal which attempts to force it down his throat. Nevertheless, we regard it as much our duty to get accurate, authoritative accounts of discoveries in science as it is to record a battle or a royal marriage."

We all know that the *Independent* is right, and the inference is plain. All reports of scientific work to be read by a willing public should be issued in two or three parts. One part might contain the detailed account of experiments performed, uninteresting save to the specialist; the long story of how the observations were made, interesting chiefly to the one who made the observations; and the long lists of names of the specimens collected, valuable mostly in making exchanges and in exciting the envy of other collectors. The second part could be made to show what great and valuable truths had been learned by experimentation or field observation, and how the species collected are related to man's welfare or may be made to contribute to his comfort. A third part should be prepared so as to be of assistance to students and to all others who desire to become naturalists. It should provide some easy method of learning what naturalists have discovered and of getting the scientific names of species of minerals, plants, and animals. To this end, natural-history manuals provided with easily understood keys and glossaries ought to be provided for the use of young naturalists and others little skilled in determining species.

The United States Geological Survey and the state experiment stations, after years of trial, have decided to publish two distinct series of bulletins and monographs, one for specialists, and the other for those interested in the economic work of the survey and the experiment stations in the several states.

While the United States Geological Survey has not as yet seen fit to issue manuals and keys for the ready determination of fossils, minerals, and rocks, the Smithsonian Institution has published in its reports several exceedingly valuable papers containing keys to species which have been very helpful to naturalists. Some of the monographs issued by our Kansas University have served excellently the same purpose.

Our own volume of proceedings is perhaps too small to admit of sharp classification of the papers on the basis of their scientific or economic value; but the lists of species and similar bald enumerations of data might be published separately, in pamphlet form, for the use of specialists.

Your speaker is confident, ladies and gentlemen of the Academy, that we shall receive larger favors from our state legislature when we in our explorations and reports pay more attention to the economic and educational interests of the people of Kansas.

It is a generally accepted truth that naturalists love their work, love its exact methods, love its honest conclusions; that they love their work more than they do their own comfort, more than they do money, and even more than life itself; and that they are seldom guilty of seeking wealth dishonestly. But, from the nature of their inherited subconscious tendencies, naturalists are not altruists. They may love the collections of another, but not the collector.

It is said of one of our most eminent paleontologists that it was never safe to leave him alone with the fossils of another unless they were in drawers and the drawers were locked.

It is certainly right to love our collections, to love our science work; but it is also certain that we need to specialize in the direction of economic value and educational value more than ever before, both because it is right, and because the people, the legislatures and the men of wealth properly refuse money for scientific surveys and scientific institutions unless the work promises to be of direct as well as indirect value to the people at large. The sudden ending of many natural-history surveys at the hands of state legislatures and the difficulty of getting appropriations for most scientific purposes should convince the most inveterate collectors that they

owe something to others as well as to themselves and their collections.

The interests of the schools lie in the same direction as the interests of the people. In days past we have been guilty of thinking that names and classifications and a little morphology, with a modicum of internal structure, were all that any student would care to know about our insects, birds, fossils, and plants. But modern and wiser science teaching demands that pupils get a knowledge of fewer things discovered by others and of more things learned by their own efforts. Knowledge in its dynamic forms, rather than information in a static condition, is what the schools need; hence the text-books must be suggestive, stimulating, and healthful, rather than satisfying. The students must be induced to collect largely and widely, both objects and information, in the field, in the laboratory, and in the library. They need to know a little of how others collect and what they discover—just enough to serve as a stimulus to personal effort. As all know, every day of the student's life must be fruitful of results; days must not pass in fruitless waiting, as is the experience of most naturalists in field and laboratory. Hence, manuals giving the essentials of what is known of each form of life of economic and scientific importance, and of each valuable rock and mineral, keys for the easy identification of every species known in Kansas and suggestions opening the way to valuable lines of inquiry should be accessible to every student and young naturalist in our state, and should be prepared by our most capable men of science.

It is exceedingly unfortunate that many teachers should feel that the items of information contained in physiologies and in old-fashioned natural histories are so important that they should be memorized by their pupils in a purely mechanical way. The results are of course disastrous. No wonder the sciences as taught in many of our high schools and in the grades are disliked by the pupils and are barren of valuable outcome. You who have read examination papers from these schools may perhaps remember some of the wonderful items of misinformation secured by this cramming of valuable facts of experience gathered by another.

A few samples of these misfit groups of unrelated ideas, gathered from sources that shall be nameless, are given as illustrations: "The alligator is the largest insect of North America." "Trypsin changes indigestible food into proteid." "The undigested food goes to the gall-bladder." "Things that are equal to each other

are equal to anything else." "The corniferous limestone is a rock in which fossil corn is found."

Thus far there have been considered the work, responsibilities and duties of the naturalist.

The work of the scientist may properly be considered next, for he follows the naturalist in line of ascent. Natural history becomes natural science when its facts are arranged in an orderly way, or so as to show laws of sequence and underlying principles. The scientist is the one who classifies the facts of observation so as to reveal underlying and related principles, and evolves from the observations and principles his great inductions in the form of theories respecting heredity, cell activities in plants and animals, social economics, the formation of the earth, the constitution of atoms and molecules, the development of the great religions, the origin of plants, animals, and even man, and observed facts in many other lines of research.

Perhaps the wonderful discoveries of truth made by the naturalist-scientist are due in large measure to his remarkably exact classifications of what he has learned by observation, experiment, and reading. While these classifications have yielded rich returns in new truths, both during their construction and in their completed form, they have also served a most important use in directing the investigations of students along fruitful lines of research, and in opening the way for mechanics and inventors to discover new ways in which known forces may be harnessed for the use of man.

While the labors of scientists have brought untold wealth to our industries, they have resulted in mixed blessings to our schools, colleges, and universities.

The scientist so loves his classifications and theories that he is loth to have them materially modified. In the classroom he is very apt to teach that they embody the whole truth and nothing but the truth. As a consequence his pupils become non-receptive to even obvious inductions of new truth.

Luther Burbank has tried to work with university graduates on his world-renowned farms at Santa Rosa and Sebastopol in his plant-breeding experiments, but he has never been able to keep in service a single university student. "Time and again some enthusiastic young fellow," according to W. S. Harwood in "New Creations in Plant Life" (page 138), "would enter upon the work, and, bred to the nomenclature and traditions of the scientists, would at once begin enlightening Mr. Burbank on the best plan to follow in a given instance, forgetting that the silent man patiently listening to him stood at the head of the plant-breeders of the world."

Used properly, the inductions, hypotheses, classifications and theories of the scientist have, as we all know, high educational value. Even the classifications, the most formal of all the work of the scientist, serve an excellent purpose in training students.

Some classifications of ideas or names, such as those found in the dictionaries and cyclopedias, are too simple to be in themselves valuable factors in education, but many of the classifications of animals, plants, minerals and chemicals are so exact in the use of terms, and are so complex in structure, that no student can run down to its appropriate species any specimen in natural history without having previously made a careful study of the form to be classified. The classification of plants in Gray's "Flora" has served as a stimulus to exact observation to a generation of amateur botanists, and so have similar works on vertebrates, birds, and insects.

I do not need to advocate in this presence the cause of the schoolmaster who wishes to make better naturalists and scientists of his pupils; but I fear, sometimes, the most of us need to be urged to make more strenuous efforts in this direction.

With a view to throwing light on the problem of conflicting evidence in court-rooms, Professor Von Liszt, of Berlin, Germany, arranged a quarrel between two of his students, the other twenty-three to have no suspicion that the event was planned.

At the appointed time the quarrel took place, amid tremendous excitement. The professor finally put a stop to it. A week later he lectured on "Evidence," having in the meantime taken the testimony of all those who witnessed the quarrel. Out of the twenty-three well-educated young men, the testimony of no two was exactly alike. No fewer than eight different persons were named as the originator of the fight, in which, actually, but two had been concerned.

The actual firing of a pistol was accurately described by nearly all, but there were four separate versions of the period of the quarrel at which it was fired. The professor's way of quelling the disturbance was described in eight different versions.

"You are like most persons," Professor Von Liszt told his students after reporting the result of this inquiry. "You look, but you do not see. It is not wilful perjurers who impede the course of justice—such persons are few—but careless people like yourselves, who have not trained the eye to report to the brain accurately what it beholds."

Throughout the major portion of the work in botany at the State Normal, students are asked to report what they see and not

what they infer; and yet this rule is unintentionally violated from one to three times, on the average, during each recitation. The students prepare in class detailed descriptions of plants they are studying, and then determine the species by using Gray's "Flora" with its several keys. After each statement of a characteristic in the key the student must pronounce judgment, subject to the criticism of the class and teacher. In this way the students are led not only to observe closely, but also to cultivate the habit of truth-telling, a practice that is exceedingly rare even in brief conversations. The ability to classify a specimen, while in itself a pleasure, also doubles the pleasure of collecting, as all know who have tried it, and greatly increases the range of objects collected.

As before stated, the young naturalists of Kansas sadly lack keys to Kansas specimens, and manuals describing their habits or qualities and economic importance.

Now that the members of this Academy have prepared fairly complete lists of the mamals, birds, reptiles, amphibians, fish, insects and other invertebrates; and of the algæ, fungi, mosses, ferns and flowering plants of Kansas, why, as before suggested, may not this Academy, through special committees, take up the work of preparing natural histories of our animals and plants, each history having its working key to the groups described? Other states have prepared these manuals with predominant economic features, and why may not Kansas? It must be done largely as a work of love; but a wonderful impetus would thus be given to the study of the sciences by the members of this Academy, by the students in the various schools of the state, and by independent workers throughout Kansas.

The third and highest stage in the development of the sciences is that of philosophy, a stage in which we love wisdom for its own sake; where man comes nearest "to thinking the thoughts of God after Him."

When naturalists have collected an abundance of data from the various fields of research among the myriad forms of plant and animal life; when scientists have classified these data in all possible ways, using, for instance, as bases, form, structure, food-getting habits, modes of offense and defense, tendencies to variation, methods of development from the fertilized egg, and the lines of development of the fossil forms dug out of the crust of the earth; and when master scientists shall have taken these classifications of the observed facts, and all the hypotheses and theories of science, and shall have sorted and arranged them with due regard to perspective,

then observation towers will be erected, with tops lifted so far above the bewildering maze of the myriad facts of observation that wide surveys can be made of the dominant truths of God's universe, and heaven-reaching generalizations be made by these master scientists, the true philosophers.

The scientific method of research provides that deduction shall follow, not precede, induction. The visions of truth, the inductions of the scientist-philosophers, help wonderfully in rectifying the work of the systematist, and in showing the naturalist where to observe, where to experiment, and where to collect.

This world does not need more potential energy so much as it needs to know how to transform more of it into useful forms of kinetic energy. So in the formation of the collecting habit, we do not need to urge more people to make collections, but we do need to urge more people to make collections that are valuable, that are useful.

It is to be deplored, for instance, that sane men and women should use valuable time in making collections of buttons, tobacco tags, old shoes, luggage labels, and postage-stamps. Not only do such collectors waste time and effort on their collections, but they also waste energy in the form of hard cash. One European collector was so dominated by the subconscious craze for the possession of rare specimens that he paid $3500 for a poorly printed two-cent stamp issued some years since by Hawaii. A blue stamp issued by a Baltimore postmaster before our general government took charge of the mails sells for $4400, and a one-cent stamp issued by Mauritius in 1847 sold recently for $4840. A Confederate silver dollar is valued at $1500, and one issued by the United States in 1804 is quoted at $1000. This craze for rare things assumes a psuedo-literary phase when collectors offer $8000 for an eighth-century manuscript of Homer's "Iliad," $6450 for the original manuscript of Scott's "Lady of the Lake," and $5250 for the autobiography of Lord Nelson in his own handwriting.

Even natural-history specimens bring absurdly high prices. A Rocky Mountain prospector ate for breakfast six eggs of the Yellow pheasant, and learned ten minutes later, to the discomfort of his digestive organs, that the eggs were worth exactly $100 each. At the time of the tulip craze in Holland, hundred-dollar tulip bulbs were common, and thousand-dollar bulbs not uncommon.

The inductions of the scientist-philosopher also serve a most excellent purpose in correcting the imperfect inductions of the scientist. It is said by G. H. Lewes that Herbert Spencer was

not so much a naturalist or scientist as philosopher; and yet his philosophic grasp of first principles enabled him to correct his friend Huxley, one of the greatest of comparative anatomists, and Hewlings Jackson, a very eminent authority on the pathology of the nervous system, in some questions of fact respecting the comparative anatomy and pathology of the cerebellum.

Spencer had had very limited opportunities for studying the comparative anatomy of animals; but his mind, skilled in philosophy, had seized and retained the essential facts of comparative anatomy as they were presented to him in conversation, in the course of his reading, and in his limited opportunities for observation, and he was thus enabled to correct specialists in their own fields of research.

These remarkable powers of the scientist-philosopher seem at times almost miraculous to those uneducated in scientific methods. He tells the astronomer where to point his instrument to discover a new world. The astronomer obeys and, behold, it is there! Or he tells the chemist that elements of certain atomic weights are needed to fill gaps in the arrangement of the elements according to the periodic law, and the chemist goes to his laboratory and finds them.

In a paper read at the Topeka meeting, objection was made by your speaker to the attempts of certain biologists to make biology a mathematical science, as are physics, chemistry, and astronomy. It was declared in the paper that the mathematician is concerned with the investigation of certain exactly statable postulates or hypotheses; that in biology, on the contrary, the one who uses the method of the mathematician can meet only with wrong results, for life obeys no law other than its own highest good, and this cannot be stated in mathematically exact terms. If the following paragraphs taken from *Science* are true, the above statement seems to need modification.

In *Science* for August 11, 1905, Dr. George Bruce Halstead, of Kenyon College, Gambier, Ohio, discusses the relationship of biology to the new mathematics, the mathematics that has given us the non-Euclidian geometry. I quote from this article. Doctor Halstead says:

"Thus, as the Russian, Alexeieff, has pointed out, after the continuity world scheme had captured the fundamental natural sciences —geometry, mechanics, astronomy, physics, chemistry—had entrenched itself in them and dowered them with generality, uniformity, universality, it went over gradually with scientific investigators,

by habit, so to say, into flesh and blood, and began to penetrate and dominate in physiology, in psychology, in sociology, in biology. . . . So we have the doctrine of a fatalist causality, denial of efficient freedom of the will, belittling of the idealistic endeavor of mankind; hence the pessimistic attitude toward the whole of human existence. . . . But the latest advances in mathematics have rendered unnecessary for biology the wearing of this misfit garment.

"The new mathematics gives now a standpoint for the explanation and treatment of natural phenomena from which the biologic elements need not be suppressed. . . .

"The continuity thought way strives to reduce all phenomena of nature to a general mechanism with fate-determined movement. Just contrary to this, then, is the view that living nature is a rationally correlated realm, in which everything is harmonic, shows adaptation, strives toward perfection."

This discovery that discontinuous variation in biology is in accord with non-Euclidian mathematics relieves students of life problems from the necessity of declaring that the method of studying the life sciences differs widely from the method of studying the mathematical and physical sciences. Darwin tried to conform in his great theory of evolution to the Euclidian continuity theory of mathematics; but the occurrence of sports among plants and animals was fatal to his theory of continuous variation. Darwin's appeal to natural selection to account for wide gaps in the ranks of plant and animal species also failed, for nature could select or reject only what life offered; and life has always persisted in offering those forms of individuals which contain parts possessed by generations of ancestors, and rarely a form with a few parts, found, perhaps, in one individual in a million, never before found on earth. These individuals, those given the new structures, and called sports or mutations, cannot be accounted for by peculiarities of environment, for they and the environment may or may not agree.

Burbank's experiments in plant-breeding have demonstrated that each species is the sum total of all past strains of heredity more or less modified by their interaction. When several species are crossed by pollination, no man knows what may be the outcome. In 100,000 hybrids produced by such crossing, Mr. Burbank found all shades of intermediate characters and many new ones. Selecting from these hundreds of thousands of hybrids those that possessed the qualities he desired, and destroying the rest, Mr.

Burbank has obtained dozens of new forms of fruits, flowers, and forage plants. By hybridization and selection he has been able to change, almost at will, old hereditary instincts and obtain the new ones he desired. Slightly modifying Mr. Burbank's statements respecting his work, he may be said to have found in his ten or fifteen years of wonderful experimentation that the powers possessed by life are the resultant of a mixed heredity from thousands of ancestors, and are, and have been, modified by life to better meet the conditions imposed by environment.

Thus the observations of Burbank as to what constitutes the true mainsprings of variation have still further emancipated life from the Darwinian, materialistic, continuity theory of variation. Thus enthroned in the thoughts of modern scientists, life may now be studied as she manifests herself in myriads of living forms, produced at her own sweet will and varied at pleasure, without invoking any tropism theory to account for her activities, or any Weismann germ plasm theory, or any Mendelian law, to limit her power to transmit her qualities or to vary them in her descendants by her own conscious powers.

Untrammeled by olden-time restrictions, the study of life has progressed by leaps and bounds. The now universally accepted theory of evolution requires that all life activities on earth shall follow one another in a definitely established order: (1) The simple shall precede the complex; (2) the variable shall end in becoming stable; (3) new characters shall be added to the old, and may overshadow and obscure them.

All evolutionists, therefore, may believe that the first activities of life were simple and variable and were consciously performed. By repetition, these in the individual, then as now, became habits. These habits persisted in by individuals for a series of generations became hereditary, subconscious activities, belonging to the species or race. And these, in turn, when they had lost the conscious element, became race instincts.

This generalization made necessary in teaching biology with life as the dominant influence has relieved the classroom of a world of trouble in explaining the relationship of reason to instinct, and of both to subconscious activity.

For example, if we regard nest-building as a subconscious activity all difficulties of explanation vanish. The tendency to build nests is instinctive and hereditary, while the act of building the nest is consciously performed and may be varied at the pleasure of the bird, as observation teaches.

In like manner we may readily explain other activities of the lower animals, such as migration of birds, ascent of rivers by fish to deposit their spawn, and all other provisions for food getting and care of young by both vertebrates and invertebrates.

The origin of instincts from subconscious activities, and these from habits and conscious activities, is a generalization in harmony not only with the doctrine of evolution, but also with the latest teachings of biologic psychology, and it denies in a very pronounced way the prevalent discordant and inharmonious theories of the materialistic biologists and psychologists.

There has been considered here the pleasure attending the work of the naturalist and scientist; that his pleasure is of the earth, earthy, compared with that which comes to the scientist-philosopher when he makes broad surveys of the fields of truth to the farther limits of God's universe.

The pleasures of the naturalist arise from the possession of things that are wonderful or rare. It has its mainsprings in an inherited, subconscious self, and is therefore deeply egoistic. The scientist may take great delight in building his classifications and in being regarded as an authority in his special department of science work; but the naturalist and scientist like best to be alone in their labors, for they demand personal credit for their collections and generalizations. On the other hand, the richer enjoyments of the philosopher arise from companionship in the search for truth, and from the contemplation of that which will bless all mankind in its fruitage.

In conclusion, it is desired to emphasize one or two things said in this address. As an Academy of Science for the state of Kansas, it is believed that it is a duty which this organization owes to the state to assist through its members more young people to become students of science, and to make our observations and experiments as naturalists, our conclusions and classifications as scientists and our broad generalizations as philosophers contribute more largely in the future than in the past to the industrial, social, intellectual and spiritual happiness of the people of our commonwealth. To this end it is hoped that the means suggested for the more ready study of the minerals, plants and animals of our state will soon be provided by the members of this Academy, either as such or as members of the faculties of our higher institutions of learning.

UNIV. OF MICH.

MUSEUM (looking west).

THE REACTION OF ANIMAL CELLS TO CHEMICAL STIMULI.

By FRANK HARTMAN, Kansas City, Kan.

AS the field of zoology broadens, our increased knowledge of the structure and behavior of animal forms drives us deeper and deeper into perplexing problems of life phenomena. The solution of many of these problems is looked for in the study of the simpler unicellular organisms. The fact that each one of these single-celled creatures is a living unit and performs all of the processes necessary to the maintenance of life makes them an attractive field of investigation.

It is the purpose of this paper to give a review of the work which has been done on the Protozoa in their relation to chemical stimuli and to give a few of the author's experiments on paramœcium. Two different classes of experiments have been carried on—first, the effect of temporary chemical stimulation on the individual animal; and second, the effect of both temporary and continued chemical stimulation on the race. The second class of experiments is manifestly more important.

The effect of chemical stimulation on the individual has been worked out by Jennings on various Protozoa. He has shown that the theory of tropisms, including chemotropism, is false when applied to the ciliates. An attempt was made by earlier investigators to make the reactions of the Protozoa conform to the tropism scheme. Tropism, in this case, chemotropism, is a direct movement or orientation of the animal towards, or away from, a diffusing chemical. In this movement the lines of diffusion bear a direct relation to the position and direction which an animal takes in moving under the influence of a chemical.

There is no doubt about the occurrence of chemotropism among plants, but no animal whose behavior has been carefully studied shows this simple reaction to chemicals. Jennings has demonstrated this fact. Among the protozoans some chemicals stimulate a motor reflex. This reflex action is a sudden backing, followed by a rapid turning of the animal toward a particular side, the one opposite the mouth. When the concentration is great enough, most chemicals start this motor reflex. In a majority of cases this action removes the animal from the source of stimulus, because the

anterior end comes in contact first. But, as Jennings has shown, if the animal is stimulated from behind, from the side or from any localized area the same reflex action takes place, even though it carries the animal into the midst of the chemical.

Some chemicals in weak solution do not stimulate the motor reflex. These are mostly those of an acid reaction. I have experimented with 0.0005 per cent. HCl and 0.00002 per cent. HCl. Several trials were made. The stronger solution did not cause the reflex, but it caused the animal to hesitate before entering. The weaker solution seemed to attract, from the fact that on contact the animal immediately swam into it. Two small drops were placed side by side, one containing the acid solution and the other paramœcium in water. Now, by the aid of a needle or a fine glass rod, the two drops are connected by a narrow neck. In its random course the little animal comes in contact with the diffusing chemical, but instead of backing off immediately it hesitates, perhaps turning toward the aboral side a few times and then entering the drop. This turning toward the aboral side is a normal movement.

After entering the drop the paramœcium darts about, showing signs of stimulation. If the connection between the two drops is small, so that the diffusion of the chemical is slow, the paramœcium, upon starting to reenter the drop of water, is repelled by having its motor reflex stimulated. The result is that the acid drop acts as a trap. If, on the other hand, the connection between the drops is large enough to permit a rapid diffusion of the chemical, instead of always being repelled by the drop of water, the animal often reenters.

The explanation is easily found. In the first instance the diffusion of the chemical is so slight that the two drops remain very different in chemical composition. Now, if an animal attempts to pass back into the drop of water it encounters such a sudden change that its reflex is stimulated, and the animal backs away. In the second instance, where the diffusion of the chemical is rapid, the drops blend into each other, so that the animal encounters no sudden change, and therefore is not repelled. Paramœcium gave a similar reaction to weak acetic acid.

What seems most peculiar in this reaction to acids is that there is no repulsion in entering the acid, but after having entered it the paramœcium is repelled by the water which it has just left. This shows conclusively that weak acid solutions have a positive attraction for paramœcia.

It has been found by other investigators that paramœcia collect in CO_2 which has been placed in the water. The CO_2 renders the

water weakly acid. It has been shown also by them that the metabolism in paramœcium, as in other animal cells, produces CO_2. Let us now place quite a anumber of paramœcia on a slide and watch their movements. In a short time they collect in groups. Is this due to a social instinct? Because paramœcia are attracted by any weak solution which gives an acid reaction, it seems obvious that the congregation of the paramœcia is due to a formation of CO_2 by the metabolism of their bodies.

If we try another class of chemicals, those of an alkaline reaction, we find that they repel.

The effect of immersion in different chemicals varies. In a one-per-cent. solution of NaCl, the organisms revolve about on their short axis and then dart from one part of the drop to the other. This restless activity is followed by short periods of rest.

A one-per-cent. solution of $MgCl_2$ does not produce so great a stimulation. Paramœcia, when immersed in this solution, dart back and forth for a short time, but soon quiet down and act normally. According to Jennings, paramœcia swim about in KI solution for six or seven minutes, giving the characteristic reflex action. This movement is followed by a continuous spinning which lasts for several minutes.

Curare produces a weakening effect after the stimulation, which lasts for about fifteen minutes. In this solution they alternate, running back and forth and spinning about, and finally become extremely quiet.

By these few examples we see how differently some chemicals affect the animal than do others. Some produce a prolonged backward movement, some produce a continued spinning, and others cause various modifications and combinations of these two movements.

Organic chemicals, such as sugars, gelatin, and urea, do not act on the motor reflex, but distend the infusorian and cause protrusions to arise on the exterior of the animal. I have experimented with sugar and gelatin. In connection with experiments with sugar a very interesting thing happened. I had a large ciliate which had been encysted for about nine months. After having tried several different methods to induce it to come out of the cyst, a solution of sugar was used. In about five hours the cyst had burst and the contents had begun to swell. The animal did not resume its active state, but immediately formed a new cyst. The osmotic pressure of the sugar undoubtedly caused the cyst to burst

and the protoplasm to swell. But the sugar solution not being suitable for the animal, it again fortified itself with a new cyst.

The behavior of the paramœcium is not radically different from that of the higher Metazoa, when subjected to chemical solution. The immediate effect is an increased activity. In many cases this is followed by a period of depression. Alcoholic stimulation in man is of the very same nature.

A study of the effect of chemicals on the individual leads one to wonder how chemical stimulation would affect the race. To determine this I have started a series of experiments. So far the chemicals used have been NaCl, $MgCl_2$, and curare. The results up to this time can be only tentative, because some of the experiments have not been carried on long enough.

On September 20 four lines of generation of paramœcia were started. Two lines were from a culture collected at Kansas City and two from a culture collected at Lawrence. In general, I used the methods which Calkins employed in his study of the life history of paramœcium. For a culture medium I used a tea made by heating a small quantity of hay in ordinary tap water. This was allowed to stand for two or three days to allow bacteria to develop. Each paramœcium culture was kept in a drop of hay tea on an ordinary glass slide. These cultures were kept in a moist chamber to prevent evaporation. The division rate was watched from day to day. At every second or third generation a single individual was removed to a clean slide by the aid of a capillary pipette and new hay tea added. Perhaps the reason why paramœcium thrives so well in hay tea is because the chemicals and food are very much like those found in its natural habitat.

For convenience, we will call the four series of cultures A, B, C, and D. After these cultures had been running for twelve days and twenty-three generations had arisen, two single individuals of A and C were isolated on separate slides. Then a culture medium made up of three parts of hay tea to one part of one-per-cent. NaCl solution was placed on the slide for the animal to live in. Records and observations were made daily. Whenever the cultures were transferred the same amount of NaCl was added to the hay tea. The normal hay series, A and C, were used as check cultures. We will call the corresponding NaCl cultures Ax and Cx. At the end of the first twenty-four hours no division had occurred in either culture. In two days two divisions had occurred in Ax and one in Cx. In five days four generations had been produced in Ax and two in Cx. Cx divided no further, but died at the end of

nine days. Ax continued dividing slowly until the eleventh day, when it ceased dividing, and died on the twenty-second day. During this time the check cultures, A and C, had divided eighteen and six times, respectively.

The check culture C shows a low state of vitality, which accounts for the early death of Cx.

For comparison, we have in the NaCl culture Ax eight generations, as against eighteen generations of the hay check culture A; and in NaCl culture Cx we have two generations, against six of the hay check culture C.

This experiment shows conclusively that continued use of NaCl retards division and finally produces death. It may be safely inferred that the continued use of any chemical produces a decrease in the vitality.

I have also started a series of experiments to determine the effect of the stimulation of an individual on the race. The chemicals employed are one per cent. NaCl, one per cent. $MgCl_2$, and a weak solution of curare. The NaCl and curare cultures are now twenty-five days old and the $MgCl_2$ culture twenty-one days old. The NaCl and curare cultures were taken from the same generation of hay culture C, while the $MgCl_2$ culture is from D. Each culture has been stimulated twice by its respective chemical for periods varying from twenty to twenty-five minutes.

Up to the present time the NaCl and curare cultures show no decided variations from the check cultures. The $MgCl_2$ culture has shown a decided decrease in vitalty. The check culture has passed through seventeen generations while the chemically stimulated one has had only twelve generations. This shows that some chemicals decrease the vitality of the race, even when given in dilute solutions and only for a few minutes at a time.

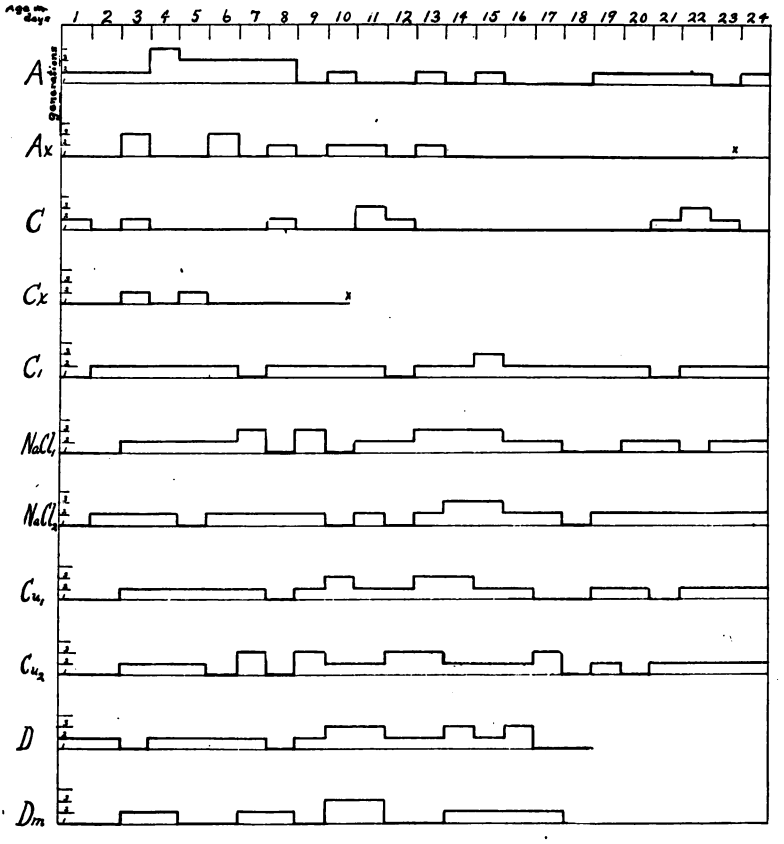
Calkins has succeeded in renewing the vitality of paramœcium by chemical stimulation when in periods of depression. He generally uses extracts from animal tissues, such as the brain, liver, and pancreas. Beef extract has been tested perhaps the most. In my own cultures, when there has been no division for six days, and the animals begin to show signs of dying, by stimulating with weak Liebig's beef extract the cultures have been restored to their normal vitality. Beef extract is not a food but a stimulant. Calkins shows that weak alcohol with continued use increases the division rate and tends to offset periods of depression. Also, that continued use of strychnine slightly increases the division rate and postpones death.

He also thinks that conjugation is a chemical stimulation which takes place by an interchange of nuclear material from individuals that have lived in different environments.

The chemical complex of the nucleus is perhaps determined by generations of varied environment and is influenced indirectly by immediate chemical change. Conjugation is probably in the nature of a chemical stimulus, but stimulation produced by crude chemical stimulation cannot produce the same result.

Loeb's well-known experiments on the unfertilized egg of the sea-urchin seems to give especial emphasis to the theory of chemical stimulation.

There is no doubt that chemical processes occupy an important place in life phenomena. Living organic matter is composed of highly complex organic compounds in a state of unstable equilibrium. Take away life and we place these complex compounds in stable equilibrium. The greater the vitality of an organism the more unstable is the equilibrium. When an organism begins to die it is approaching stable equilibrium. Slight variations in the chemical composition in the fluid supplied for the nourishment of a cell probably tends to maintain this unstable chemical equilibrium for a while; but in time this unstable equilibrium must be reenforced by a delicately complex stimulation from the nucleus of another individual.



Graphic representation of daily division rates of cultures, showing comparison between the chemically stimulated and the normal hay-fed series.

A, Ax, C, Cx, are the "NaCl continued stimulation series." Of these A and C are the check cultures, while Ax and Cx are the cultures stimulated continually with one per cent. NaCl. X marks the day on which death occurred.

C_1 is the check series for $NaCl_1$, $NaCl_2$, Cu_1, and Cu_2. $NaCl_1$ and $NaCl_2$ cultures were stimulated twice with one per cent. NaCl for periods of twenty-five minutes each. Cu_1 and Cu_2 cultures were stimulated twice with a weak solution of curare for periods of twenty minutes each.

D and Dm are the "$MgCl_2$ comparative series." D is the check culture, while Dm has been stimulated once with one per cent. $MgCl_2$ for twenty minutes.

THE CHEMICAL PROCESSES FOR THE DETECTION OF ORGANIC SUBSTANCES AND MEDICINAL CHEMICALS.

By L. E. SAYRE, University of Kansas, Lawrence.

THE new (1900) United States Pharmacopœia, which has just been published and officially issued, contains a number of organic compounds which have found their way into medicine and are considered of importance among remedial agents. Among these new agents we find:

Acetone, phenacetin, camphoric acid, trichloracetic acid, ethyl chloride, antipyrine, urethan, benzaldehyde, saccharine, bromoform, chloral formamide, cinaldehyde, cresol, guaiacol, guaiacol carbonate, hexamethylenamine, iodol, salol, safrol, sulfonal, thymol iodide, vanillin, etc.

As it is the province of the pharmacopœia to give approximate tests for identification of the agents made official and to supply methods for the detection of the impurities that may be found in them, it is interesting to note some of these tests.

For this purpose we have selected a few of these organic remedial agents and the tests employed for detection of impurities—those tests that chemists have considered sufficiently reliable to be placed in the hands of any one trained in chemistry. We selected from the list the following organic chemicals and their accompanying tests:

SALOL, or PHENYL SALICYLATE, $C_6H_4(OH)COOC_6H_5$ 1:2.

This substance is apt to contain, as a result of the process of its manufacture, some uncombined phenol, or a minute quantity of salicylic acid. The test for these impurities is as follows:

If 1 gm. of phenyl salicylate be shaken with 50 c.c. of water, the liquid filtered, and 5 drops of ferric chloride t. s.* previously diluted with 20 volumes of water be added, the filtrate should show either no color or at most a trace (limit of uncombined phenol or salicylic acid).

ANTIPYRINE, $C_3HN_2O(CH_3)_2.C_6H_5$.

Is liable to be contaminated or adulterated with acetanilid and acetphenetidin. The tests which apply to these possible admixtures are as follows:

Two c.c. of an aqueous solution of antipyrine (1 in 100) mixed

* t. s. = test solution.

with an equal volume of nitric acid assumes a yellowish color, passing to crimson on warming (distinction from acetanilid and acetphenitidin).

On warming 0.1 gm. of antipyrine with sodium hydroxide t. s., and again warming after the addition of chloroform, the disagreeable odor of phenyl-isocyanide should not be developed (absence of acetanilid).

BENZALDEHYDE, $C_6H_5.COH$.

Has been introduced as an article, artificially produced, to take the place of the natural oil of bitter almonds as a material for flavoring. An aqueous or alcoholic solution of either of these may be used in pastry or other material, giving the peach or almond flavor. The objection to the natural oil of almonds, in some cases, is that it contains as a natural constituent hydrocyanic acid. Benzaldehyde will therefore become a popular substitute, for the better, and to guard against adulteration (or substitution) of benzaldehyde by the oil of bitter almonds, a test for the presence or absence of hydrocyanic acid is introduced, which reads as follows:

If ten drops of benzaldehyde, dissolved in a little alcohol, be shaken with a few drops of a strong solution of sodium hydroxide, then with a little ferrous sulfate t. s., and finally mixed with a slight excess of hydrochloric acid, a blue precipitate should not be produced (absence of hydrocyanic acid).

SACCHARINE, $C_6H_4\left\langle\begin{matrix}SO_2\\CO\end{matrix}\right\rangle NH$ (BENZOSULPHINIDE).

May be adulterated with glucose, with benzoic or salicylic acid. These are tested for as follows:

Glucose.—If 0.2 gm. of benzosulphinide be dissolved in 5 c.c. of potassium hydroxide t. s., the solution should be clear, and not become colored, even on prolonged heating (absence of glucose).

Benzoic acid.—If to a hot aqueous solution of benzosulphinide ferric chloride t. s. be added, drop by drop, no precipitation or violet color should appear (absence of benzoic or salicylic acids).

CRESOL (also known as TRICRESOL), $C_6H_4(CH_3)OH$.

This article is a mixture of the three isomeric cresols obtained from coal-tar, an antiseptic of growing popularity. It should be free from hydrocarbons and phenol. The absence of these is detected in the following way:

Hydrocarbons.—If 1 c.c. of cresol be mixed with 1 c.c. of an aqueous solution of sodium hydroxide (1 in 10), it should be dis-

solved with no appreciable liquid residue (absence of, or limit of, hydrocarbons).

Phenol.—If 1 c.c. of cresol be mixed with 1 c.c. of glycerin, a clear solution should be produced, from which, on the addition of 1 c.c. of water, the cresol should completely separate (absence of, and distinction from, phenol). Phenol forms a perfectly transparent solution with this glycerin and water solvent.

THYMOL IODIDE, $(C_6H_2.CH_3.C_3H_7.OI)_2$.

This article, which has much popularity, is an antiseptic, known by the commercial name of aristol. It should be free from the alkalies, free iodine, and foreign bodies. These are appropriately tested for, but the one test of the pharmacopœia, which will eliminate many of the substitutes that have been marketed for this favorite antiseptic, is the "limit of ash" test, which reads as follows:

If 0.1 gm. of thymol iodide be thoroughly ignited in a porcelain crucible, it should leave not more than 0.003 gm. of residue (limit of ash).

VANILLIN, $(C_6H_3.OH.OCH_3.COH$ 4:3:1).

This expensive, fragrant organic compound is very tempting to the unscrupulous merchant as a substance to be very easily adulterated with such a substance as acetanilid; therefore an appropriate test is found in the pharmacopœia to betray the presence of this adulterant, which reads as follows:

On warming 0.1 gm. of vanillin with concentrated alcoholic solution of sodium hydroxide, adding chloroform, and again warming, it should not give an odor of phenyl-isocyanide (absence of acetanilid).

The author of this paper commented upon the various tests mentioned, and not only showed their importance but gave his personal experience in the employment of them.

A CHEMICAL STUDY OF THE LIME AND SULFUR DIP.

By ROSCOE H. SHAW, Manhattan.

LIME and sulfur dips were brought to the writer's attention some two years ago by Dr. N. S. Mayo, at that time state veterinarian. The problem to be solved then was the remedying of a turbidity which ensued when the concentrated ooze was diluted with the ordinary hard water of the Western plains. One thing led to another, until the work extended intermittently over a period of about one year. Among the phases of the subject taken up was one concerning the chemical changes taking place in the dip when exposed in open vats. Such exposure is the usual occurrence in practice when two immersions are made with a ten-day period between them. During this interval the vats are sometimes partly covered with boards, but more often are left entirely exposed.

The purpose of this paper is to present some of the results obtained in this phase of the investigation.

The dip used was made according to the Fort Collins formula, as given in Bulletin No. 21 of the Bureau of Animal Industry, Department of Agriculture. According to this formula, lime and sulfur, in the proportion of one to three, are boiled with water. Commercial lime and ordinary flowers of sulfur were employed and distilled water used in diluting.

In order that laboratory conditions should conform as closely as might be with those obtaining on the ranch, miniature vats were constructed of wood, with all cracks and seams made tight with paraffin. The vat containing the dip which is discussed in this paper was of the style known as the swimming vat, a type in common use in western Kansas. It was eight feet long, six inches deep, and five inches wide.

The vat was filled with dip made as before stated, but diluted somewhat more than is called for by the formula. Each morning, at a definite hour, the contents of the vat were mixed and sampled. During the day a crust formed, which was broken up each morning in order to secure something of the effect of the wind on the vats in practical use. Under ordinary conditions the wind also accelerates the evaporation, but in this experiment no attempt was made artificially to produce the result. Another difference was that the vat, being indoors, was not exposed to sudden changes of temperature, such as would occur in practice.

In sampling, small quantities were taken from different parts of the vat; these were well mixed and a subsample taken for analysis. Care was taken to start the determinations immediately after sampling.

The diluted dips are of an orange-red color. On standing exposed to the air an incrustation soon forms, which consists of calcium carbonate and free sulfur. If this incrustation is broken it falls to the bottom of the containing vessel and a fresh incrustation forms. A slight jarring or even a breath of wind is sufficient to break up this crust; so after standing for some time there will be a layer of sediment on the bottom of the vessel as well as a crust on top, both being of the same chemical composition.

Qualitative analysis of the dip showed presence of calcium sulfides, polysulfides, and thiosulfate. At all times hydrogen sulfide was evolved, due probably to the action of the atmospheric carbon dioxide on the sulfide.

If sulfites and sulfates were present they were in such slight amounts as would be negligible. The absence of quantitive amounts of the last two was somewhat surprising, as it is well known that thiosulfates in solution are converted slowly to sulfites and sulfates according to these reactions:

$$CaS_2O_3 = CaSO_3 + S.$$
$$CaSO_3 + O = CaSO_4.$$

If this decomposition and oxidation takes place in the dip at all it takes place very slowly.

To the writer's knowledge there is no method known for separating the polysulfides of calcium. An attempt was made by employing a freezing mixture of snow and calcium chloride and partially freezing the concentrated ooze, as the dip is called before diluting. The chemical composition of the frozen and the unfrozen portions showed, however, that little or no separation was accomplished.

Necessarily, then, the determinations were limited to those of total sulfur, total calcium, and calcium thiosulfate. By subtracting the calcium and sulfur calculated from the percentage of the thiosulfate from the total calcium and sulfur, percentages were obtained which represented, approximately at least, the calcium and sulfur existing in the combined sulfides. In no case in a large number of analyses of dip did this percentage correspond to that of any one of the polysulfides. Usually it fell between the tetrasulfide and pentasulfide, and could always be assigned to a mixture of the mono- and the pentasulfide. This will be spoken of later in the paper.

The specific gravity was determined in each case, both as a factor in itself and as a means for converting volume into weight.

QUANTITATIVE METHODS EMPLOYED.

Determination of Specific Gravity.—The determinations of specific gravity were made by means of a Geissler's pycnometer, with a capacity of about fifty cubic centimeters, and provided with a delicate thermometer.

Determination of Thiosulfate.—In this determination the sulfides of calcium were removed by means of cadmium. Five cubic centimeters of the dip were stirred into about twenty-five cubic centimeters of freshly boiled distilled water to which had been added a quantity of a five-per-cent. solution of cadmium chloride sufficient to completely precipitate the sulfides. The resulting cadmium sulfide settled at once, was quickly filtered off, and left a clear filtrate. This filtrate was titrated with decinormal iodine solution, using freshly prepared starch as indicator.

Determination of Calcium.—Twenty-five cubic centimeters of the dip were pipetted into a 250 cubic centimeter measuring flask and diluted to the mark with freshly boiled distilled water; twenty-five cubic centimeters, representing two and one-half cubic centimeters of the original dip, were immediately pipetted out into a beaker; two cubic centimeters of a saturated solution of potassium hydroxide and an excess of bromine water added. The beaker with contents was then placed on a hot plate and digested at just below the boiling-point to the complete oxidation of the sulfur. After cooling, hydrochloric acid was added to acid reaction and the excess of bromine removed by reheating. Ammonia was added to alkalinity and the calcium precipitated by adding a sufficient quantity of five-per-cent. ammonium oxalate solution. It was found that less trouble from cloudy filtrates was experienced if this as well as the barium sulfate precipitate spoken of in the next paragraph was allowed to settle for twenty-four or thirty-six hours in a warm place. It was then filtered on an ashless paper filter, ignited to the oxide in a muffle furnace, and immediately weighed.

Determination of Total Sulfur.—In the determination of total sulfur the same procedure was followed as for calcium up to the point of precipitation, when to the hot acid solution a sufficient quantity of a ten-per-cent. solution of barium chloride was added; the resulting precipitate of barium sulfate, after standing as mentioned above, was removed by means of a Gooch filter and filter pump, ignited at low redness, and weighed.

Determinations according to the above methods were made daily up to and including the tenth day, then on the thirteenth day, and again on the sixteenth day.

The results of these direct determinations are given in table I. In table II the figures given are calculated from those in table I. From the percentage of calcium thiosulfate the percentage of calcium so combined is calculated. These figures are given in the second column.

TABLE I.

DAY.	Specific gravity.	Thio-sulfate.	Calcium.	Sulfur.
1	1.0264	0.30%	0.72%	2.24%
2	1.0269	.38	.79	2.35
3	1.0273	.69	.83	2.33
4	1.0277	.87	.82	2.34
5	1.0281	.90	.87	2.35
6	1.0282	.93	.82	2.33
7	1.0284	.96	.83	2.35
8	1.0286	1.00	.85	2.36
9	1.0289	1.03	.85	2.35
10	1.0291	1.07	.84	2.35
11*	.....	.....	.....	.....
12*	.....	.....	.....	.....
13	1.0305	1.18	.84	2.35
14*	.....	.....	.....	.....
15*	.....	.....	.....	.....
16	1.0307	1.29	.86	2.36

* Not determined.

TABLE II.

DAY.	Calcium in thiosul-fate.	Calcium in sulfides.	Sulfur in thiosul-fate.	Sulfur in sulfides.	Per cent. calcium and sulfur of thiosul-fate of total cal-cium and sulfur.
1	0.08%	0.64%	0.13%	2.11%	6.93%
2	.10	.69	.16	2.19	8.28
3	.18	.65	.29	2.04	14.87
4	.23	.59	.37	1.97	18.99
5	.24	.63	.38	1.97	19.25
6	.25	.57	.39	1.94	20.32
7	.25	.58	.40	1.95	20.44
8	.26	.59	.42	1.94	20.97
9	.27	.58	.43	1.92	21.88
10	.28	.56	.45	1.91	22.81
11	.....	.....	.....	.....	.....
12	.....	.....	.....	.....	.....
13	.31	.53	.50	1.85	25.39
14	.....	.....	.....	.....	.....
15	.....	.....	.....	.....	.....
16	.34	.52	.54	1.82	27.33

As previously stated, it has been assumed from the absence of appreciable quantities of sulfite and sulfate that the balance of the calcium is combined as sulfides. This figure obtained by subtracting calcium in the thiosulfate from the total calcium as given in the third column of table I.

In the third column, the sulfur calculated from the percentage of calcium thiosulfate is given, and in the fourth column the difference between this last and the total sulfur is given as sulfur in sulfides.

The percentage of calcium and sulfur in calcium thiosulfate to the total calcium and sulfur is given in the fifth column.

The days in the first column of each table, of course, correspond.

There is much difference of opinion among authorities concerning the sulfides of calcium. Contradictory statements may be found regarding even the more common sulfide, the monosulfide, and opinions differ as to whether or not the others have ever been prepared in a pure state. According to Mendeleeff,* in an admixture with calcium thiosulfate, by boiling a solution of lime or calcium monosulfide with sulfur, calcium pentasulfide is formed, according to this reaction:

$$3Ca(OH)_2 + 12S = 2CaS_5 + CaS_2O_3 + 3H_2O.$$

The same authority ignores the existence of any polysulfides between the mono- and the pentasulfide.

According to Dammer,† both the penta- and the tetrasulfide exist, and may be prepared by boiling calcium monosulfide with the proper proportion of sulfur and water. He recognizes two other compounds also—Herschell's crystals, having the formula, $3CaO.CaS_4.12H_2O$, and Bushner's crystals, $4CaO.CaS.18H_2O$, which may be formed under slightly modified conditions.

To quote Watts:‡ "When CaS is boiled with S and H_2O it dissolves, forming an orange-red solution, the quantity of S which goes into solution corresponds with that required to form CaS_4 and CaS_5; if more S is used, it is deposited on cooling the liquid; if less S than S_3 to CaS is used, some of the CaS remains undissolved. Both solutions are decomposed on concentration with precipitation of $Ca(OH)_2$ and S and evolution of H_2S."

It is seen that there are several possible compounds of calcium and sulphur which might be present in the dip. No attempts were made to separate the sulfides other than the single unsuccessful attempt by freezing, and consequently the data given in this

* Mendeleeff's Principles of Chemistry, vol. II, p. 214.
† Dr. O. Dammer, Handbuch der Anorganischen Chemie, II Band Theil, p. 311.
‡ Watts's Dictionary of Chemistry, vol. I, p. 214.

paper throw little light on the manner in which calcium and sulfur are combined as sulfides.

In the course of the investigation, of which this paper records but a part, many dips were analyzed. Every dip, when analyzed, gave percentages of calcium and sulfur combined as sulfides and as calcium thiosulfate. These figures varied somewhat, but could always be assigned to a solution of various mixtures of monosulfide of calcium, one or more of the polysulfides of calcium, and thiosulfate of calcium.

For the sake of simplicity and for comparison, it is assumed that the dip is a solution of a mixture of monosulfide of calcium, pentasulfide of calcium, and calcium thiosulfate, the relative proportions of which may vary, and of course would vary in a dip exposed to the air, if they decompose at different rates. Some illustrations may be given:

$$2CaS.18CaS_5.5CaS_2O_3.$$
$$5CaS.6CaS_5.3CaS_2O_3.$$

It is not believed that so simple a mixture is the true one, but for comparing results in the vat experiment the above possibility is given.

Some interesting facts may be noted by turning to table I. In the first vertical column it will be seen that the specific gravity is constantly and regularly increased. This increase is due, first, obviously to concentration from evaporation of the water; secondly, to the oxidation of the sulfides. In the next column it will be seen that the percentage of the calcium thiosulfate constantly increases, the greatest increase occurring in the first three days of the experiment. The total increase was 0.99 per cent. in the sixteen days, an average of 0.063 per cent. per day. This increase in calcium thiosulfate may be ascribed to two causes: First, to the concentration, as shown in the increase of specific gravity; and second, to the oxidation of polysulfides from the oxygen in the air:

$$CaS_5 + O = CaS_2O_3 + S_3.$$

(The rate of evaporation was found in a later experiment for the same vat and same kind of dip to be 40.16 per cent. for sixteen days; so the thiosulfate from this cause alone would have increased from 0.3 per cent. on the first day to about 0.5 per cent. on the sixteenth day.)

In the third column the percentage of total calcium shows a constant and regular increase. There are at least two independent agents acting here: First, concentration acting to increase the per-

centage; and second, the decomposition of the sulfides by atmospheric carbon dioxide throwing out the calcium as calcium carbonate, and thus tending to decrease the percentage.

In the fourth column may be seen the percentages of total sulfur. After the second day this percentage remains practically constant, varying only 0.03 per cent. As with calcium, there are several changes affecting these figures: First, concentration, tending to increase the percentage; second, decomposition of sulfides by carbon dioxide in the air forming, (*a*) in the case of polysulfides, volatile hydrogen sulfide and insoluble sulfur, and, (*b*) in the case of monosulfides, volatile hydrogen sulfide only, tending to decrease the percentage; and third, oxidation to polysulfides and thiosulfates, thereby throwing sulfur out of solution. These three agencies, and perhaps others acting in the same and different directions, produce equilibrium in the percentage.

If there were sulfites or sulfates present, we would expect a further decrease in percentage total sulfur, owing to the throwing of sulfur out of solution according to the reactions,

$$CaS_2O_3 = CaSO_3 + S, \text{ and}$$
$$CaSO_3 + O = CaSO_4.$$

A study of table II will reveal some other interesting facts. The columns representing calcium and sulfur calculated from the percentage of calcium thiosulfate of course show the same rate of increase as the thiosulfate column in table I.

The column giving percentages of calcium in sulfates shows a constant decrease, as would be expected, since the increase of calcium in thiosulfate must have been at the expense of the calcium in the sulfide. The same holds true for the sulfur in sulfides.

On the first day the ratio of calcium in thiosulfate to calcium in sulfides was 0.08 to 0.64, or as 1 to 8; on the sixteenth day the ratio of calcium in thiosulfate to calcium in sulfides had increased to 34 to 52, or more than 5 to 8.

Likewise the ratio on the first day of the sulfur in the thiosulfate to sulfur in the sulfides was 1 to 13, while on the sixteenth day it had increased to nearly 4 to 13. This disagreement between the two ratios would be expected if the explanation regarding the calcium and sulfur in table I be accepted. The ratio of calcium in sulfides to sulfur in sulfides on the first day is 64 to 211, while on the sixteenth day the ratio had changed to 52 to 182, or, in terms of the first, to 64 to 224. This difference in ratio in calcium and

sulfur is easily explained if it be accepted that the dip is a mixture of two or more sulfides decomposing at different rates.

Assuming, for the sake of comparison, as has been stated before, that the dip is a solution of a mixture of monosulfide, pentasulfide, and thiosulfate, then on the first day $2CaS + 7CaS_5 + CaS_2O_3$ would correspond to the different percentages, while $CaS + 9CaS_5 + 5CaS_2O_3$ would represent the mixture for the percentage given on the sixteenth day.

ON THE DURABILITY OF CEMENT PLASTER.

By E. H. S. BAILEY and W. G. STROMQUIST, University of Kansas, Lawrence.

FORMERLY the only material used for inside plastering was lime mortar, and upon this was spread a skim coat made from plaster of Paris. Since the discovery of extensive beds of gypsite or gypsum dirt, in various localities in Texas, Indian Territory, Kansas, and Wyoming, this material has been heated to drive off nearly all of the water, and is put upon the market under the names of Agatite, Acme, Alabastine, etc., as a substitute for lime mortar. As this crude gypsum occurs in beds where it can be handled by a grader, loaded on wagons, and hauled directly to the mill, the production of this kind of plaster has become an important industry. While the ordinary gypsum rock must be ground before it can be heated in the kettles, this material needs no preliminary treatment.

The composition of the raw gypsite, the finished product and the set plaster is as follows: *

COMPONENT PARTS.	Raw.	Finished.	Set.
	%	%	%
Silica and insoluble residue	12.29	14.31	12.03
Iron and aluminum oxids	2.27	2.16	1.62
Magnesium carbonate	.78	.91	.61
Calcium carbonate	8.01	9.42	8.07
Calcium oxid	2.12	1.85	1.89
Calcium sulfate	57.95	66.22	59.37
Water	16.07	4.91	16.38
Totals	99.49	99.78	99.97

From an examination of the analyses, it will be seen that the crude material loses all but about five per cent. of its water when "boiled," and when water is added to the "plaster," before spreading on the wall, it retains practically the same amount of water as it lost when heated; and in fact it again becomes gypsum, or $CaSO_4+2H_2O$.

For practical work, the mason mixes with the cement plaster from three to five parts of sand, and a little "retarder" is used to prevent the too rapid setting. This material has been used for plastering walls for the past fifteen years, and, as far as observed, it seems to last as well as lime mortar.

An opportunity to study the disintegration of this plaster under

* University Geological Survey of Kansas, vol. V, p. 163.

peculiar conditions was recently afforded the author. In the Chemistry building at the State University, which was completed in 1900, there is a room which is plastered on the sides, and in which is situated the fan which ventilates the building. On one side this room is partially open to the air, and cold air is drawn over hot steam-pipes in the cold weather as it enters the room. The air is then drawn through the fan into the flues, by which, after passing over other steam-coils, it is distributed throughout the building. The temperature of the air in the fan room varies with that of the outside air, ranging probably in the winter from 40° F. to 72° F.

It was noticed that the plastering on both sides of the room, above a line extending from the floor on the sides nearest the pipes to the ceiling on the opposite side, had become powdery, and fallen off. In order, if possible, to find the cause of this, several analyses were made of the hard plaster which was still in place in the wall and of that which had fallen off, with the following results in one case:

Component parts.	Original plaster.	Fallen plaster.
Silica and insoluble residue	74.41%	76.42%
Iron and aluminum oxids	2.45	1.18
Magnesium carbonate	1.64	1.09
Calcium carbonate	3.09	6.18
Calcium sulfate	13.58	12.72
Water	4.75	1.98
Totals	99.92	99.57

Other samples gave:

Water	4.76%	1.57%
Water	4.56	2.05

As the samples are taken from different parts of the wall, they will not agree in composition. An inspection of the analysis, however, shows that in every case the fallen plaster contains less than half as much water as the plaster which is in place on the wall. Comparing this analysis with those previously given, we can also form some estimate of the amount of sand that is used with the original material.

It is generally conceded that the setting of plaster of Paris is due to interlacing of the small crystals of gypsum, which are formed in the moist material, and we are familiar with the fact that if all the water is driven out of the gypsum in heating, the plaster will not readily "set." It is evident, then, that about five per cent. of water is necessary to the stability of the finished wall.

The disintegration of the wall of this room may be accounted for by considering that the cold air, as it is warmed by its passage over the steam-pipes, quickly acquires a greater capacity for taking up moisture, and so it abstracts moisture from the nearest available source, namely, the plaster of the walls; this plaster having lost the water that is necessary to form the crystals of gypsum, falls to pieces just as it would before the blowpipe.

It is a well-known fact that the lime-plastered wall will fall to pieces if kept very damp for considerable time, and this is also true of walls made of cement plaster. There is no record, however, of hot, dry winds tending in any way to injure walls of this material, and it is probable that only under the special conditions mentioned above this disintegration could take place.

III.

GEOLOGICAL PAPERS.

"THE UNIVERSITY OF KANSAS EXPEDITION INTO THE JOHN DAY REGION OF OREGON."

By C. E. McCLUNG, University of Kansas, Lawrence.

"THE LOUP FORK MIOCENE OF WESTERN KANSAS."

By CHARLES H. STERNBERG, Lawrence.

"ADDITIONAL OBSERVATIONS ON THE GEOLOGY OF KANSAS."

By LYMAN C. WOOSTER, Emporia.

THE UNIVERSITY OF KANSAS EXPEDITION INTO THE JOHN DAY REGION OF OREGON.

By C. E. McClung, University of Kansas, Lawrence.

THE University of Kansas takes pride in its natural-history museum, the largest of any state institution in the country, and almost annually sends one or more expeditions into the field to add to the collections. These explorations have covered a good part of western North America, but until last summer no Kansas party had visited the extreme northwestern portion of the United States. With a desire to make the material in the museum as representative as possible, the zoology department conducted an exploration through the John Day region of central Oregon in search of mammalian fossils. It has been the custom to record in the Transactions of the Kansas Academy of Science the general nature of the explorations conducted by the museum, and for this reason I thought it desirable to make some mention of the one sent to Oregon.

The party, consisting of Messrs. Martin, Baumgartner, Hoskins, and myself, all of the zoology department, outfitted at La Grande and started west over the Blue mountains on July 1. The collecting ground had not been approached from this direction, and it was hoped that some advantage might accrue from this fact, but experience showed that the limited size of the field placed no premium upon any particular entrance into it. This will be apparent from the description of the region which I will give.

The John Day river has its head waters in the eastern range of the Blue mountains, and in its earlier course traverses a roughly triangular basin bounded by different spurs of these mountains. Within this basin there are three divisions of the river—the north fork, the east fork, and the south fork—which unite together before the stream finally turns north to flow into the Columbia river. It is upon the main river, which, just before joining the north fork, runs north and south, that the principal collecting grounds are found. Through the elevated basin the various branches of the river meander, cutting great canyons down through the Columbian lavas that overspread the whole of this part of Oregon. The entire region is indescribably rough, and when one views the relatively low-lying basin from an elevation it appears as if a veritable carni-

val of chaos had disported itself over the land. Such an assemblage of crags, ridges and mounds it would be hard to imagine. A few level spots are found along the streams, but the valleys are very narrow, and it is with extreme difficulty that roads are made. And even when they are once established there are many chances that they will not endure, for heavy waterspouts rush down the narrow canyons piling up great boulders and excavating deep gorges across and along the passageways. There is as great a fear of these deluges in the mountains of Oregon as there is of cyclones upon the plains of Kansas. It is but a few years since the small town of Heppner lost over 500 lives in one of these visitations. Vegetation is very scanty, and the whole region is bare and uninviting.

Into this arena we penetrated with difficulty, after a long journey over the mountains, and settled down to work on the main river in a locality called Turtle Cove. This is a fairly representative portion of the region, and I will describe it in some detail. Just here the river runs almost due north and south for a distance of about twenty miles, through a valley that will average about five miles in width. The hills rise precipitously on each side to a height of about 1500 feet, and from their bases long, slanting terranes extend in toward the river, which winds in and out at the bases of their interdigitating extremities. As many as twenty-two lava-beds may be seen in the hills, and for most of the distance in Turtle Cove they lie approximately horizontal. The terranes are largely composed of lava fragments, but now and then exposures of the John Day formation may be seen lifting themselves into prominence against the darker colored background.

Merriam makes three divisions of the John Day deposits, the lower, middle, and upper, and all of these may be found in Turtle Cove. The lower offers no attractions to the paleontologist, for animal remains have not been found in it, but the peculiar rounded hills into which it forms on exposure make a most striking landscape. Almost all colors of the rainbow may be seen, but the prevailing ones are chocolate red and pea-green. Frequently the dark red mounds are banded with undulating stripes of white, which produces a most bizarre effect. The shades of color vary with the direction of the light, but always have a soft effect. On close inspection the mounds are found to be covered with about six inches of loose soil, cracked into small bits, and it is to this condition that the varying shades of color and the soft effect are due. Underneath their superficial layer the unweathered shale constitut-

ing the mound is to be found. It is rarely that the lower John Day is to be seen lying underneath the upper layers; more commonly the area occupied by this formation is an exposed valley whose floor is covered by ascending series of these mounds which finally abut against the lava hills.

The middle and upper John Day series resemble each other and differ materially from the lower. They occur in steep cliffs of ashy gray or bright green color, and weather into vertical columns which rest upon harder layers, usually of white or pink, that extend approximately horizontally through the face of the exposure. The whole mass of material is cracked and seamed, and consists of hardened nodules, between which is a softer matrix of the same sort of material. When the irregular hardened masses are exposed on all sides they slake off in concentric layers, which break down and finally leave only scattered fragments of flint-like hardness. These small pieces of hard substance lie upon all surfaces where they can lodge and make the footing of one who climbs upon the cliffs very uncertain. Such exposures occur only occasionally, and there would seem to be no continuous formation over the whole basin. Whether there ever was such a one is very uncertain, but if this was the case then there must have been very extensive weathering and erosion before the Tertiary lava flows buried the region.

The individual exposures of the middle and upper John Day are from 100 to 500 feet high, and in the search for specimens it is necessary to crawl over the surface of these almost vertical cliffs and to look very carefully for bone fragments. Compared with many other collecting grounds in the Miocene there are here comparatively few specimens, but by careful work we were able to find enough to keep us busy most of the time. It is a very difficult matter to remove the bones in good condition because of the lack of homogeneity in the matrix. On digging into the cliff after a specimen it will be found that for a part of the distance the bones will lie in the hard nodules, and will then for a while extend along in the seams that are filled with much softer material. For this reason it is impossible to remove any large part of a skeleton in one piece, and the individual bones have to be carefully removed and pasted up in cloth. The bones themselves, however, are in an excellent state of preservation and make beautiful specimens.

Most of the fossils in this region are mammalian, but in some places turtles are numerous. The commoner specimens belong to

the family of the Oredons, which have a considerable range in size. These animals are now entirely extinct and show characters belonging both to deers and pigs. Primitive horses of several genera are common, as are also various camels and rhinoceroses. Primitive pigs, cats and dogs are found here, but we were not fortunate enough to secure many specimens of them. Rodents of various kinds are not uncommon.

There is not a little dispute about the age of the beds and the manner of their deposition, but the consensus of opinion seems to be that they are Miocene lake deposits. From the nature of the beds and the contained fossils, it would appear as though the lake were shallow and subject to frequent filling up with ashy deposits. The character of the material and the condition of the skeletons embedded in it would seem to indicate that the animals had fallen into a muddy place that later had been cracked by drying, and then once more had been subjected to a mud flow that had filled up the earlier cracks. Only a very careful study of the whole region, after the manner of that conducted by Merriam, would make it possible to determine the nature and sequence of the changes that were involved in the laying down of these interesting deposits.

Our party spent the greater part of the summer in the Turtle Cove region and then descended the river into the Haystack Valley locality. A short time was spent here, and then we took our way over the mountains to make the bend of the river where Bridge creek flows into it. In this historical collecting ground we had no success, and were obliged to end up the season with the least successful expenditure of our time. We left the John Day basin on the west side, after having traversed it from one end to the other, and, from the elevated plateau that bounds it, looked back upon the broken and serried ridges through whose valleys we had been wandering. It was a sight to be long remembered, and I believe there are few like it elsewhere. We reached a branch railroad at Shaniko and here shipped the greater portion of our freight. Final disposal of our team and wagon was made at The Dalles, on the main line, and from this time on we were in civilized surroundings to which there attaches no interest.

THE LOUP FORK MIOCENE OF WESTERN KANSAS.

By CHARLES H. STERNBERG, Lawrence.

IT may seem like telling an old story to speak in this Academy of the Upper Miocene formation. However, as the writer made the first large collection of vertebrate fossils in it, and has spent five seasons there, including the one just past, he hopes to give some information of value in connection therewith.

For countless ages animals have lived out their allotted span, have fought the ever-recurring fight for food and life, and they were finally stricken down by their fellow creatures or by the pitiless forces of nature. The same blind forces covered the remains in the ooze of old ocean, the silt of the lake, or backwater from an ancient stream overflowing its flood-plain, covering the bones with loads of sand or mud. In the course of centuries the burial-places are lifted high and dry, and by the denudation of land in excavating some river valley or during the recession of cliffs their bones are exposed. Under the patient skill of the collector they are secured from their resting-places. In the past fifty years many noble skeletons of the animals have been gathered into museums. Men of wealth are collecting the faunæ of many geological horizons, so that it is now possible to get a good idea of the ancient history of animal life on our earth.

It should humble us "lords of creation." Like the older Agassiz, we should uncover our heads when we, enter a paleontological museum, for we stand in the presence of the wonderful works of the creator—works which until only recently has man looked upon with intelligent eyes. In July, 1877, the writer was ordered north from Buffalo Park by Prof. E. D. Cope, in search of fossil vertebrates in the valley of the Loup Fork of Nebraska. An old-line hunter, Abernathy by name, chanced to be at Buffalo selling his last lot of buffalo hides. He spoke of a skull of an elephant in a ledge of sandstone above his cabin. Following this information, the writer, with his assistants, Russell T. Hill and Wilbur Brouse, was delighted to find the first Loup Fork vertebrate he ever collected. It was a great land turtle. These rocks are too old for the elephant; the top of the carapace was so exposed as to seem to an ordinary observer like the back of the head of a large beast. This find was on the middle fork of Sappa creek, some fifteen miles above Oberlin, which place then consisted of a store building in which a

general stock of everything needed by the first pioneers of that part of the state were sold. Parts of Decatur and Rawlins counties were explored, and here were discovered the rhinoceros, three-toed horse, and other animals of the Upper Miocene. One thing frequently noted here was the conglomerate of gravel or fine sand bound lightly together with the chalk that had been washed into whiting by the streams that flowed over the Niobrara group of the Cretaceous rocks that lie immediately underneath. Where masses of this material have disintegrated at the foot of some cliff, the resemblance to old, weather-beaten mortar is so great as to attract instant attention. It is pleasant to know that the geologists of Kansas now call these "mortar beds." The resemblance in many instances was real, as the early settlers plastered the inside walls of their sod houses by simply mixing water with it, and laying it on with an ordinary trowel.

The great land turtle discovered on the Sappa was named *Testudo* (*Xerobates*) *orthopygia* by Cope. Here was also found the short-limbed rhinoceros, called at that time *Aphelops fossiger* Cope, the generic name meaning without horns, as they were absent in the female skull Cope described. As the late Dr. J. B. Hatcher found them on the male, he changed the generic name to *Teleoceras*. In 1882, while in the employ of the museum of comparative zoology of Harvard, the writer discovered the famous locality at Long Island, Phillips county. In 1884 he was employed to explore this deposit for Professor Marsh, of the United States Geological Survey, and, with the assistance of J. B. Hatcher, who was at that time an enthusiastic student from Yale, and who made the first collection of his life there, they collected about ten tons of the bones of rhinoceros, representing many individuals. Professor Marsh leased this quarry, and at once it took the name of the Marsh quarry. A narrow ravine cuts through the center of the deposit. The bones lie scattered along either side of the ravine for a quarter of a mile, often in pockets, or pot holes, in the hard sandstone layer. There are two of these layers, about fourteen feet apart. The interspace is filled with beds of fine molding sand, with some whiting, formed by the wash of the underlying chalk, which when these beds were laid down formed the land surface. There are also beds of sand that have been washed clean by some old current in the flood-plain of an ancient river, for the exposed section shows all the different deposits of a river valley. Above the washed sand is a stratum of sand and clay, showing that the muddy backwater had deposited in a quiet place its load. This layer, on exposure, cracks

in all directions, like the mud in the bottom of a puddle after the water has evaporated.

It has always been a problem to account for the great number of animals represented, and the fact that the bones are all scattered. No two bones are in their natural position; all parts of the skeleton are mingled in the greatest confusion. One would of course be forced from his observation of this region to agree with Doctors Matthew and Hatcher as to the fact of the deposition of these bones in the flood-plain of a running stream of water and not in great lakes, as was believed by the older geologists. The only way the writer has been able to account for the intermingling of all the bones of the skeletons on the bottom sandstone layer is, that as this sand when thoroughly saturated with water would become quicksand, the bones, scattered through the fourteen feet above where they now lie, would sink in it until the impenetrable bottom layer was reached. When the land had not been cut by drainage channels one can readily believe that the above idea would account for the mingling together indiscriminately of the bones of the many skeletons. What caused the death of such vast numbers of rhinoceroses in this place is a question not easily answered. The authorities quoted believe that during great floods all the animals in the vicinity sought the highest point they could find to escape death, but at last their efforts were in vain, and they were drowned in the flood that covered every inch of land. After maceration took place the bones might have been scattered by other floods. Another and equally plausible theory of the writer is that the animals were buried beneath a great sand-storm that tore lose the fine sand of the flood-plain and scattered it in suffocating volume over the frightened multitude, which had sought safety or courage by herding together. One can readily agree with the gentlemen referred to, that, during the Upper Miocene time, there were many watercourses separated by slightly elevated divides and broad flood-plains. Possibly here and there were small lakes where the dense vegetation had clogged some sluggish stream. During a rainy season the whole region for many miles might be converted into lakes and the animals driven from their haunts, and, worn out in efforts to escape, would at last succumb to the inevitable. Another thought in this connection is, that the land was not then elevated above the sea-level more than a few hundred feet. Now it is 3000 feet. This would account for the tropical climate, the slow, sluggish streams, bordered everywhere with swamps, filled with rushes

and sponge moss, while in the more solid ground trees and shrubs, like those of the tropics, raised their heads to the sun.

Last season the writer discovered the most complete set of lower jaws of the great inferior tusked mastodon, at the Sternberg quarry. The jaws miss part of the end that are united at the sympathis and prolonged forward into a broad rostrum, into which the inferior tusks are inserted. These tusks are absent in this specimem, though very complete ones have been found that have fallen out of their sockets, and show that they projected eighteen inches from the jaw, the roots reaching back about two feet to the last molar, that in this set had full possession; the other molars had been cast out. The length of the preserved jaws was two feet six and a half inches. Height at condyles, fourteen inches. In the center of the grinding surface of the last molar the height is nine and a half inches. The length of the molar is about seven and a half inches, and three and a half inches wide. The great distinguishing character of this first mastodon lay in the fact that only a narrow strip of enamel covered the inside of the tusk, while in all the descendants the tusks are encircled with enamel.

The dominate life in northwestern Kansas at that time was the rhinoceros, *Teleoceras fossiger*, and the great land turtle, *Testudo* (*Xerobates*) *orthopygia* Cope. As early as 1882 a large collection of these turtles was made in a narrow gulch that had been carved out of the sand by water on Beaver creek, near the old site of a town of that name.

A great deal of labor was required to secure specimens from the Loup Fork sands. The turtle shells were scattered through sand about four feet in thickness along the face of the bluff for 100 feet; about six feet below was the bed-rock, on which were scattered rhinoceros and other bones. The fact that the limbs were present in many cases precludes the possibility of their sinking in quicksand after death, as, in that case, the loose bones of the endoskeleton would have been left behind; for the same reason they could not have been brought to burial by water very long after death.

During Pliocene time, a little later, the great elephant, *Elephas columbi*, ranged in great numbers over the same region. In 1894 the writer discovered a large deposit of these bones, which are preserved in the University of Kansas.

ADDITIONAL OBSERVATIONS ON THE GEOLOGY OF KANSAS.

By LYMAN C. WOOSTER, Ph. D., Emporia.

ILLUSTRATION OF CLASSIFICATION FORM.

Formations.	*Times.*	*Rocks.*
Paleozoic	Eon.	Series.
Carbonic	Era.	System.
Coal Measures or Kansan	Period.	Group.
Upper Coal Measures or Upper Kansan	Epoch.	Stage.
Lower Coal Measures or Lower Kansan	Epoch.	Stage.
Emporia Beds	Hemera.	Beds or substage.

Carboniferous Rock System of the Carbonic Era.

Thickness, 5555 feet. Time, about 2,500,000 years.

The rock groups and the corresponding time periods:

I. Mississippian.
II. Coal Measures, or Kansan.
III. Permian.

I. ROCKS OF THE MISSISSIPPIAN PERIOD.

But one rock stage of the Mississippian period is represented in Kansas, that of the Keokuk epoch.

1.—Strata of the Keokuk Epoch.

The rock beds found in southeastern Kansas. Thickness, about 400 feet.

(1) *Galena (Boone) Beds,* thickness about 400 feet. These consist of layers of bluish limestone. In the upper portion of these beds the limestone has been extensively eaten out, probably by water containing carbon dioxide, and great quantities of chert, lead sulfide and zinc sulfide have been deposited in the cavities. The ores of lead and zinc are extensively mined at Galena, and in the vicinity of Joplin, Mo. The annual output is worth about $10,000,000 for both metals. The ores are smelted at Cherryvale, Iola, Chanute, Neodesha, and Pittsburg. At about the close of this epoch, the Galena beds were raised above the level of the sea and deeply eroded by sub-aerial agencies. The amount of this erosion is unknown. A deep well at Emporia reached the Galena beds of the Mississippian limestone at a depth of 1920 feet. The level of the surface at the mouth of the Emporia well is 1130 feet above the level of the sea; the level at Galena above the same datum plane is 870 feet. The distance from Galena to Emporia in a straight line is 118 miles; therefore the dip of the Galena beds

in the direction of Emporia is about sixteen feet to the mile, assuming that the upper layers of these beds exposed near Columbus would have an elevation of 1100 feet at Galena were they still exposed at that place.

II. ROCKS OF THE COAL MEASURE OR KANSAN PERIOD OF THE CARBONIC ERA.

Thickness, 2780 feet.

1.—Strata of the Lower Coal Measure or Lower Kansan Epoch.

The rock beds found in eastern Kansas. Thickness, 1440 feet. (The layers are described, beginning with the lowest.)

(1) *Cherokee Beds*, thickness, 450 feet. This formation consists largely of shales, a few thin layers of limestone, several beds of sandstone of various thicknesses, becoming increasingly prominent to the southward, and of seven or more beds of coal. The shales are valuable for brick-making, and the sandstones serve as rich reservoirs of petroleum and natural gas under a belt extending from Paola to Coffeyville and south into Indian Territory. The Weir City coal-bed, situated about 200 feet above the base of the Cherokee beds, yields the coal mined near Pittsburg and probably that mined at Atchison, Leavenworth, and in eastern Indian Territory.

Nearly eighty-five per cent. of the coal, ninety-nine per cent. of the natural gas and ninety-nine per cent. of the petroleum mined in Kansas are obtained from the Cherokee beds. It is estimated that, during 1904, 5,000,000 tons of coal, 7,000,000 barrels of petroleum and an unknown number of billion cubic feet of gas were obtained from these beds; and that from these and the other beds of the Lower Coal Measures were obtained 150,000,000 brick of various kinds and 2,700,000 sacks of cement—all, coal, oil, gas, brick, and cement, worth more than $16,000,000.

The Cherokee beds dip heavily to the southward in southeastern Kansas, increasing to a thickness of more than 9000 feet in eastern Indian Territory. Probably these beds in Indian Territory are the source of the petroleum and natural gas of eastern Kansas. If so, middle Kansas does not overlie this sheet of gas and oil, and, therefore, cannot obtain them from the sandstones of the Cherokee beds.

The Cherokee beds outcrop in Cherokee, Crawford and Bourbon counties, but are penetrated by wells and shafts throughout eastern Kansas, as they dip at a small angle to the westward. Fossils are not abundant in these beds.

(2) *Labette Beds*, 110 feet. These consist of the Fort Scott (Oswego) limestones, twenty-five feet; Labette shales, sixty feet;

and the Pawnee limestone, twenty-five feet. The limestones abound in low anticlines and synclines, and may be easily traced along a line extending from Fort Scott southwestward. Excellent outcrops may be found near Girard, Oswego, and Parsons. The lowest limestone is burned for cement near Fort Scott. Fossils are abundant near the decomposing limestones. The shales thicken to the southward.

(3) *Pleasanton Beds*, 275 feet. These beds include the Bandera (Lower Pleasanton) shales, 100 feet; Parsons (Altamont) limestone, 25 feet, and the Dudley (Upper Pleasanton) shales, 150 feet. The Parsons limestone thins northward and disappears near Pleasanton. Coal is mined at Pleasanton, and some thin layers of sandstone are quarried for flagging on the Marmaton river near Fort Scott. The shales are thicker southward.

(4) *Erie* (*Bronson*) *Beds*, 275 feet. These include the Hertha (Bethany Falls) limestone, 15 feet; Ladore (Mound Valley) shale, 100 feet; Mound Valley limestone, 10 feet; Cherryvale (Galesburg) shales, 120 feet, and Independence (Dennis) limestone, 30 feet. The limestones of the Erie beds are best developed to the northeastward, and become thinner bedded and more argillaceous to the southwestward. They contain many fossils. The shales thicken southward, and contain much arenaceous material. They supply excellent clay for vitrified brick, especially at Cherryvale. The Erie beds are a dominant feature of the topography of the country from eastern Miami county to eastern Montgomery county. The shales thin to the northward.

Remarks: In the eastern part of Allen and the western part of Bourbon counties the Erie (Bronson) beds lose in part the shale strata, and the limestones thicken so as locally to form an almost continuous bed of limestone sixty to eighty feet in thickness. This is one of the heaviest of the limestones penetrated in drilling for oil. The Independence limestone of these beds carries a large amount of flint in its lower portion; the upper portion is an oolite which exhibits cross-bedding and false bedding, and attains a thickness in some places of fifteen feet.

(5) *Iola Beds*, thickness 330 feet. These include Chanute (Thayer) shales, 150 feet; Iola (Earlton) limestone, 30 feet; Concreto (Lane) shale, 75 feet; Allen (Stanton, Garnett, Carlyle) limestone, 30 feet; Vilas shale, 45 feet. The shales of the Iola beds are better developed in thickness southward, and the Chanute shales contain much sandstone in the central and southern counties

and in Indian Territory. The sandstone is not well cemented and is everywhere ripple-marked, showing shallow-water deposition. The limestones become thinner-bedded to the southward and are inconspicuous. Thin beds of coal in the shales are mined locally. The Iola beds outcrop along a belt extending southwestward from Kansas City, Mo., by Paola, Iola, and Fredonia, to western Montgomery county. Portland cement is manufactured from shale and limestone at Iola. A warping of the crust of the earth by which the deep seas were shifted from south of Kansas to north of Kansas makes the close of this hemera a proper time for dividing the Coal Measure or Kansan period into Lower and Upper Coal Measures, or Lower and Upper Kansan epochs.

2.—Strata of the Upper Coal Measure or Upper Kansan Epoch.

The rock beds found in eastern Kansas. Thickness, 1340 feet. (The layers are described, beginning with the lowest.)

(6) *Lawrence Beds*, 310 feet. These include Piqua limestone, 50 feet; Le Roy shales (Lawrence shales, north; Chautauqua sandstone, south), 220 feet; Oread limestone, 40 feet. The shales thicken northward, and are replaced by sandstones southward. A few thin beds of coal are mined locally in the shales, and some light flows of natural gas have been obtained from them by wells at Eureka. The important towns located on or near the outcrop of these beds are Troy, Atchison, Leavenworth, Lawrence, Burlington, Toronto, Yates Center, Fall River, Elk Falls, and Sedan.

(7) *Lecompton Beds*, 280 feet. Kanwaka shales (Elgin sandstone, south), 100 feet; Lecompton limestone, 20 feet; Tecumseh shales (Cave Springs sandstone, south), 75 feet; Deer Creek (Strawn) limestone, 25 feet, and Calhoun shales, 60 feet. The shales are thicker north, and quite arenaceous in the southern part of the state. The limestones do not form conspicuous ledges, except on the Kaw river and in the southern counties. Fossils are very abundant, especially in the vicinity of the limestones. The important towns on or near the outcropping of this belt of beds are Lecompton, Lyndon, Hilltop and Virgil in Greenwood county, Elk Falls in Elk, and Elgin in Chautauqua county.

(8) *Eureka Beds*, 230 feet. Hartford (Topeka) limestone, 25 feet; Severy (Osage) shales, 70 feet; Howard limestone, 7 feet; Burlingame shales, 120 feet; and Barclay (Burlingame or Eureka) limestone, 8 feet. All these limestones, especially the last, form prominent escarpments across the state. The eighteen-inch bed of coal mined at Osage City, Burlingame and Scranton lies at the top of the Severy shales, just under the Howard limestone. Several

thin beds of coal are found in the Burlingame shales, and yield some coal by stripping. Hiawatha, Holton, Topeka, Osage City, Eureka, Howard and Cedarvale are situated along this belt of beds. The Burlingame shales eight miles east of Emporia contain so much arenaceous material that in certain portions they are better designated as sandstones. These arenaceous shales are intersected vertically by numerous fissures, many of which show faulting. About thirty feet below the Barclay limestone is a two-foot stratum of concretionary limestone covering a six-inch stratum of coal, and fifty-five feet below the Barclay limestone is a stratum of brecciated and conglomeritic limestone, locally thirty-five feet thick. The same or another stratum of breccia and conglomerate is found above the concretionary limestone mentioned above, and another thin stratum above the Emporia limestones, described below, is widely distributed in Lyon county.

(9) *Emporia Beds*, 216 feet. These comprise the Humphrey shales, including Columbia Ford limestone, 36 feet; Emporia blue limestone, 9 feet; Olpe shales, 60 feet; Emporia buff limestones, 34 feet, and Emporia reservoir shales, 77 feet. The Humphrey shales yield much salt water, to the detriment of wells. The Emporia blue limestone holds its special characteristics throughout Lyon county and probably also in the counties north and south, and is much used in the construction of foundations to houses. The Emporia buff limestones are five in number, vary considerably in physical appearance, hold many fossils in the limestone layers and in the intervening shales, and are locally used somewhat for building stones. Beneath the Emporia buff limestones the Olpe shales are in part quite arenaceous. These shales contain a thin bed of coal in the middle part. The Emporia reservoir shales are quite uniformly arenaceous and carry at the top a six-inch bed of coal.

(10) *Americus Beds*, 155 feet. These comprise the Admire shales and limestones, 120 feet; Americus limestone and shales, 35 feet. The Admire shales include some five strata of limestone and sandstone, none of which is of especial importance commercially or topographically. About ninety feet above the base the shales yield small quantities of natural gas in western Lyon county, and larger quantities at Strong City and Elmdale, in Chase county. The Americus limestone is a valuable building stone. It is dark buff in color and averages twenty inches in thickness. Six or eight feet above the Americus limestone is a six-inch layer of limestone

much used for sidewalks. The shale between these limestones is very rich in fossils.

(11) *Elmdale Beds*, 150 feet. One-third of the thickness of these beds is limestone, and the remainder is shaly limestone and shale. Of these limestones, three deserve special mention: The Friable Fusulina, twenty-four feet above the base of the beds, contains myriads of rhizopods. The Neva limestone, forty-six feet below the top, is twelve feet in thickness. The upper half was named "cotton rock" by Swallow, an early Kansas geologist, and the lower half was named "dry bone," from its peculiar appearance when weathered. The Cottonwood limestone, twelve feet from the top of the Elmdale beds, is one of the most highly valued building stones of middle Kansas. It is a white limestone, and lies in a stratum six and one-half feet in thickness. The twelve-foot shale bed above this limestone is literally full of fossils and becomes excellent soil on decomposition.

The Elmdale beds lie at the summit of the Coal Measures of Kansas. No unconformity exists between these beds and those above, but Permian fossils are increasingly abundant.

III. ROCKS OF THE PERMIAN PERIOD OF THE CARBONIC ERA.

Thickness, 2375 feet.

1.—Strata of the Lower Permian Epoch.

The rock beds found in central Kansas. Thickness, 565 feet. (The layers are described, beginning with the lowest.)

(1) *Strong City Beds*, 180 feet. These include Crusher Hill alternating shales and limestones, 140 feet. The limestones offer little resistance to atmospheric influences, and, therefore, have little influence on topography. The stratum next above is the Strong flints (Wreford limestone), 40 feet. This formation is chiefly responsible for the Flint Hills of central Kansas, because of its power to resist erosive agencies. The layers of limestone have been replaced wholly or in part by silicious material, and are much used, when crushed, for railroad ballast. The Flint Hills, or, as they were named by the earlier geologists of Kansas, the Permian mountains, extend across the state from Nebraska to Oklahoma, but are best developed in Chase, Greenwood, Butler, Elk, Cowley and Chautauqua counties.

(2) *Florence Beds*, about 159 feet. These consist of Cedar Point (Matfield) shales and shaly limestones, about 92 feet; Florence flints and shaly, buff limestone, 37 feet; Fort Riley (Florence) limestones, 30 feet. In the midst of the Florence flints are one or two heavy layers of white limestone, quarried at El Dorado for fine

building stone. The shaly, buff limestones above the Florence flints contain an abundant brachiopod fauna near Florence, and the shaly limestone above the heavily bedded Fort Riley limestone contains an abundant lamellibranch fauna near Fort Riley.

(3) *Marion Beds*, about 230 feet. The lower portion of these beds consists of various colored shales and shaly limestones, about sixty feet. The next section of the beds contains the Marion gray limestone, with more or less flint, then some yellowish shales, and Marion concretionary limestone; in all thirty feet. The Marion concretionary limestone contains many brachiopods. This is the highest and latest formation of which this is true, for the higher and later formations of the Marion beds are characterized by a very abundant lamellibranch fauna. The next 140 feet of the Marion beds consists of variously colored shaly limestones, with the Abilene conglomerate at the top. This last consists of pebbles of limestone and quartz cemented together. The great change in the physical geography of central Kansas at the close of the deposition of the Marion beds, shown by the absence of fossils from the succeeding beds and the deposition in them of large quantities of salt and gypsum, makes it seem wise to separate the Lower Permian from the Upper Permian at this horizon.

2.—Rocks of the Upper Permian Epoch.

The rock beds found in southwestern Kansas. Thickness, 1810 feet. (The layers are described, beginning with the lowest.)

(4) *Wellington Beds*, about 400 feet. These consist lowest of buff limestones and marls, then of colored shales and marls alternating with layers of gypsum and thick deposits of rock salt, and lastly of variously colored shales and marls. In central and northern Kansas the Wellington beds are succeeded by the massive dark brown and red sandstones of the Dakota Cretaceous; in southern Kansas the Wellington beds are covered by the sandstones, long known as the "Red Beds," belonging to the Upper Permian. Cragin has characterized the Wellington beds as made up of "a thick body of blue, gray and slate-colored shales." Thus far no fossils have been reported from them. Salt is mined at Kingman, Lyons, and Kanopolis, and is pumped at Anthony, Wellington, Hutchinson, and Sterling.

(5) *Harper Beds*, 650 feet. These are the red and variegated sandstones of the Red Beds so well exposed in Kingman and Harper counties. These beds are continuous with similar beds which outcrop in Oklahoma. The sandstones and shales were de-

posited over a continuously subsiding sea bottom, but always in shallow water, as is shown by the ripple-marks to be found in nearly every layer. No fossils have been found in these beds in Kansas, but, in Oklahoma, Gould reports the discovery of vertebrate, invertebrate and plant remains. The animals belong to Permian types, and the plants resemble Mesozoic rather than Paleozoic types, according to European standards.

(6) *Medicine Lodge Beds*, 500 feet. These consist of the Salt Plain shales, containing salt and gypsum, 150 feet; Cedar Hill sandstones, 150 feet; Flower-pot shales, 170 feet; Medicine Lodge (Cave Creek) gypsum, 29 feet. On the discovery of fossils in Oklahoma in strata geologically more than a hundred feet above the Medicine Lodge gypsum, Gould classed the strata above as Triassic; but a more careful study of these fossils shows that they belong to Permian types, and it is therefore probable that the Texas Trias does not extend north into Kansas. In southwestern Colorado the Permian Red Beds and the Triassic are unconformable.

(7) *Kiger Beds*, 260 feet. These consist of Dog Creek shales, 30 feet; Red Bluff sandstones, 200 feet; Day Creek dolomite, 10 feet; Hackberry shales, 20 feet. The fossils referred to in (6) were found in the Red Bluff sandstones. The Kiger beds close the Paleozoic in Kansas. The whole region covered by Coal Measure deposits was elevated at the close of the Paleozoic It remained dry land during the Triassic and Jurassic of the Mesozoic, and was deeply eroded; and then was submerged, in the western half of the state, beneath the waters of the ocean and covered by the deposits of the Cretaceous era, and later, as the land slowly emerged from the ocean during the rise of the Rocky Mountains in the next tier of states, west, became covered by the brackish and fresh-water deposits of the Tertiary and Quaternary eras.

IV.

BIOLOGICAL PAPERS.

"DETERMINATIONS OF SOME TEXAS COLEOPTERA, WITH RECORDS."
By ELBERT S. TUCKER, University of Kansas, Lawrence.

"ADDITIONS TO THE LIST OF KANSAS DIPTERA."
By F. F. CREVECŒUR, Onaga.

"THE EFFECT OF LIGHT ON MELILOTUS ALBA (SWEET CLOVER)."
By R. W. COPPEDGE, Mulvane.

"ADDITIONS TO THE LIST OF KANSAS COLEOPTERA, 1905."
By W. KNAUS, McPherson.

"COLLECTING INSECTS AT NIGHT."
By ELBERT S. TUCKER, University of Kansas, Lawrence.

"ADDITIONS TO THE LIST OF KANSAS ARACHNIDA."
By THEO. H. SCHEFFER, Manhattan.

"THE RED PHALAROPE (CRYMOPHILUS FULICARIUS), A NEW BIRD FOR THE KANSAS LIST."
By L. L. DYCHE, University of Kansas, Lawrence.

"NOTES ON SOME MOSQUITOES OF DOUGLAS COUNTY."
By CHAUNCEY OVERMAN, University of Kansas, Lawrence.

"SOME RESULTS OF THE UNIVERSITY OF KANSAS ENTOMOLOGICAL EXPEDITIONS TO GALVESTON AND BROWNSVILLE, TEX., IN 1904 AND 1905."
By F. H. SNOW, Lawrence.

"SOME RESULTS OF THE UNIVERSITY OF KANSAS ENTOMOLOGICAL EXPEDITIONS TO ARIZONA IN 1904 AND 1905."
By F. H. SNOW, Lawrence.

DETERMINATIONS OF SOME TEXAS COLEOPTERA, WITH RECORDS.

By ELBERT S. TUCKER, Museum Assistant in Systematic Entomology, University of Kansas, Lawrence.

ON account of personal interest in the insect fauna of Texas, due mainly to my first entomological collecting trip in the state (to Galveston, in May, 1904, as a member of a party under direction of Dr. F. H. Snow, for the University of Kansas), the writer consented to identify some beetles from the collection of the Agricultural and Mechanical College of Texas, at College Station, Brazos county, on the request of Prof. A. F. Conradi, then acting state entomologist. As a motive for the work other than the advantage accruing to the college collection, Professor Conradi proposed that a list of determinations thus obtained would be helpful in making up a general list of the Coleoptera of Texas, and the names and records herewith show the results of study of the specimens which he furnished. All determinations were personally made by comparison with named specimens in the collection of beetles of the University of Kansas, together with the aid of literature, excepting those species so indicated in the list, where special credit is given to the authority to whom the specimens were submitted in cases of uncertainty. With the exception of *Balaninus victoriensis* Chitt., all of the beetles were collected in Texas, mostly at the Agricultural and Mechanical College, to which institution they have been returned, less a few duplicates retained by kind permission. The student will notice that many dates of collecting occurred in early spring and, in fact, winter months, which indicates that where mild winters prevail a long season for insect activity is permitted.

The arrangement follows Henshaw's check-list by numbers when given.

Family CICINDELIDÆ.

19*a* Cicindela scutellaris Say, var. unicolor Dejean. Wellborn, Brazos river, March 22, 1904.

32 Cicindela vulgaris Say. Wellborn, Brazos river, March 22, 1904.

Family CARABIDÆ.

184 Calosoma lugubre Le Conte. College Station.

220 Scarites subterraneus Fabricius. College Station, March 31, 1904.

387 Bembidium variegatum Say. College Station, May 9, 1903.

617 Evarthrus heros Say. Comanche, March 17, 1904.

847*a* Casnonia pennsylvanica Linnæus, var. suturalis Chaudoir. College Station, January 30, 1903; Buffalo Springs, May 5, 1903.

935 Pinacodera platicollis Say. College Station, January 4, 1904. Striæ not deep; abdomen protrudes farther beyond elytra than with compared examples, regarding which Mr. Charles Liebeck has written: "About the usual form; the extent of abdominal segment beyond the elytra is variable."

1068 Discoderus impotens Le Conte. College Station, May 1, 1904. Determined by Charles Liebeck.

1120 Harpalus gravis Le Conte. Waco, September 20, 1902. Collected by L. H. Scholl.

1201 Anisodactylus piceus Le Conte. College Station, February 27 and May 1, 1904; Avalon, April 12, 1904. The brownish-tinged examples were probably freshly emerged when captured; hence, had not developed to black.

Family GYRINIDÆ.

1539 Dineutes carolinus Le Conte. College Station.

Family COCCINELLIDÆ.

3064 Cycloneda sanguinea Linnæus. College Station, May 12, 1904; also May 10, 1905 (C. E. Sanborn). Predaceous on plant-lice.

3065*a* Olla abdominalis Say. Sabinal, May 24, 1904.

3084 Exochomus constritatus Mulsant. College Station, May 10, 1905 (C. E. Sanborn). Predaceous on plant-lice.

3098 Brachyacantha bollii Crotch. College Station, June 4, 1903. Determined by Charles Liebeck as "large form." The yellow spaces of basal and median portions of elytra are solidly fused, without any indication of spots. Also taken at College Station, May 10, 1905, by C. E. Sanborn, who reported it as predaceous on plant-lice.

3135 Scymnus terminatus Say. College Station, August 8, 1904.

3156 Scymnus tenebrosus Mulsant. College Station, May 10, 1905 (C. E. Sanborn). Predaceous on plant-lice.

Family EROTYLIDÆ.

3202 Languria tædata Le Conte. College Station, April 12, 1903.

Family ELATERIDÆ.

4085 Lacon rectangularis Say. College Station, February 27, 1904.

Family BUPRESTIDÆ.

4575 Psiloptera drummondi Laporte and Gory. College Station, June 20, 1902. Determined by Charles Liebeck.

4639*a* Chrysobothris femorata Fabricius, var. alabamæ Gory. Kosse, April 19, 1904.

4750 Agrilus muticus Le Conte. College Station, April 28, 1903, and April 7, 1904.

Family MALACHIDÆ.

5007 Collops balteatus Le Conte. Wellborn, Brazos river, March 29, 1903; College Station, July 27, 1902.

Family CLERIDÆ.

5215*a* Chariessa pilosa Say, var. onusta Say. College Station, April 13, 1903.

Family PTINIDÆ.

5356 Amphicerus bicaudatus Say. Corsicana, March 11, 1904.

Family SCARABÆIDÆ.

5535 Aphodius serval Say. College Station, January 7, 1904. Smaller than compared examples, more deeply striate with confluent punctures, and with slightly different markings, regarding which Mr. Charles Liebeck has written: "About the usual size; markings variable."
5581 Ochodæus biarmatus Le Conte. Sabine, May 24, 1904.
5591 Bolboceras lazarus Fabricius. College Station, April 14, 1904.
5691 Macrodactylus angustatus Beauvois. College Station, March 30, 1904.
5692 Macrodactylus uniformis Horn. College Station, March 30, 1904.
5742 Lachnosterna torta Le Conte. College Station, July 8, 1904.
5894 Allorhina nitida Linnæus. College Station, July 23, 1904.
5901 Euphoria kernii Haldeman, (typical). Cedars, May 28, 1904.
5941 Trichius viridulus Fabricius. Wellborn, Brazos river, March 30, 1904.

Family CERAMBYCIDÆ.

5953 Mallodon dasystomus Say. College Station.
5955 Mallodon serrulatus Le Conte. Wellborn, Brazos river, June 24, 1904.
5962 Prionus inbricornis Linnæus. College Station, May 1, 1904.
6008 Callidium antennatum Newman. College Station, February 5, 1903.
6038 Chion cinctus Drury. Victoria, August 13, 1904.
6050 Romaleum atomarium Drury. College Station, June 10, 1904.
6115 Callichroma plicatum Le Conte. No data.
6127*a* Tragidion coquus Linnæus, var. fulvipenne Say. College Station, February 16, 1903.
6196 Neoclytus luscus Fabricius. Wellborn, Brazos river, June 24, 1904.
6201 Neoclytus erythrocephalus Fabricius. Wellborn, Brazos river, August 12, 1904.
6471 Ataxia crypta Say. Manor, October 5, 1904.

Family CHRYSOMELIDÆ.

6725 Fidia viticida Walsh. No data.
10352 Fidia cana Horn. Dripping Springs, May 17, 1904. Determined by Charles Liebeck. Badly crushed and broken.
6800 Chrysomela disrupta Rogers. Courtney, October 7, 1902. Collection of L. H. Scholl.
6821 Chrysomela auripennis Say. College Station, December 12, 1903.
6978 Haltica nana Crotch. College Station, September 19, 1903. Verified by Charles Liebeck.
7032 Mantura floridana Crotch. College Station, May 1, 1903.
7051 Chætocnema opacula Le Conte. College Station, May 1, 1903.
7055 Chætocnema confinis Crotch. College Station, May 1, 1903.

Family TENEBRIONIDÆ.

7179 Conœcus ovipennis Horn. Comanche, August 17, 1901. Determined by Charles Liebeck.
—— Emmenastus convexus Le Conte. Coleman, August 23, 1902.
7201 Epitragus acutus Le Conte. Sabinal, May 24, 1904.
7359 Eleodes seriata Le Conte. College Station.
7426 Opatrinus aciculatus Le Conte. College Station, December 20, 1903.

7438 Blapstinus pratensis Le Conte. Cororado, August 11, 1903; College Station, April 12, 1903, and February 27, 1904.
7573 Helops farctus Le Conte. College Station, June 10, 1904.

Family MORDELLIDÆ.

7780 Mordella scutellaris Fabricius. College Station, September 16, 1902.

Family ANTHICIDÆ.

7869 Eurygenius wildii Le Conte. No data.

Family MELOIDÆ.

8018 Henous confertus Say. College Station, May 28, 1903; Wellborn, Brazos river, June 24, 1904.
8083 Epicauta sericans Le Conte. Montgomery, August 24, 1903.
8123 Pomphopœa texana Le Conte. Thornberry, April 4, 1903.

Family ATTELABIDÆ.

8224 Attelabus analis Illiger. College Station, July 27, 1904.

Family OTIORHYNCHIDÆ.

8242 Ophryastes vittatus Say. Comanche, November 14, 1904.
8326 Achrastenus griseus Horn. Lovelady, March 24, 1904; Grape Vine, no data; Sidney, April 4, 1904. Determined by Charles Liebeck.
8340 Eudiagogus pulcher Fahræus. Wellborn, Brazos river, August 27, 1904; College Station, January 30, 1903.

Family CURCULIONIDÆ.

8370 Apion ovale Smith. Rockdale, June 22, 1901.
8478 Pachylobius picivorus Germar. Hughes Springs, May 11, 1904; College Station, June 10, 1904; De Kalb, August 1, 1904. The last was in prime condition, neither rubbed nor smeared.
8546 Desmoris constrictus Say. College Station; Center Point, June 1, 1904. Regarding this species Prof. A. F. Conradi has written: "This species occurs abundantly over the entire settled portions of the state of Texas definitely known."
8615 Magdalis barbiti Say. Howe, March 22, 1904.
10985 Anthonomus grandis Boheman. College Station, June 12, 1904.
8726 Conotrachelus naso Le Conte. College Station, October 20, 1904.
8741 Rhyssematus palmacollis Say. Frost, May 28, 1904. "Hillsboro, Malakoff, Victoria, and in fact it occurs all over the state," writes Professor Conradi. Variety, with costæ, apical margin and spots on elytra rusty red colored. Verified by Charles Liebeck.
8746 Chalcodermus æneus Boheman. Denison, June 27, 1904.
8760 Acalles porosus Le Conte. San Antonio, March 30, 1904; Martindale, April 14, 1902.
8902 Aulobaris ibis Le Conte. College Station, December 18, 1904.
—— Balaninus victoriensis Chittenden. Mead, Indian Territory, September 20, 1904; Lone Wolf, Oklahoma, September, 1904. Determined by F. H. Chittenden.

Family BRENTHIDÆ.

8967 Eupsalis minuta Drury. Wellborn, Brazos river, June 24, 1904.

Family CALANDRIDÆ.

8990 Sphenophorus cariosus Olivier. Moody, March 25, 1904. Determined by F. H. Chittenden.

9006 Sphenophorus compressirostris Say. No data. Determined by F. H. Chittenden.

Family ANTHRIBIDÆ.

9222 Cratoparis lugubris Olivier. College Station, January 4, 1904.

SUMMARY: Species personally determined	76
Species specially determined	9
Number of species reported	85

ADDITIONS TO THE LIST OF KANSAS DIPTERA.

By F. F. CREVECŒUR, Onaga, Kan.

THE following list of Diptera which have not before been listed from the state were all collected by me near my home near Onaga. A number of uniques, and a few undetermined species which are probably undescribed, are not included in this list, but will be reserved until some future time, when I expect to list them along with a lot of Microdiptera which so far I have not taken the trouble to collect. From the number of new species taken the last year or two, and the limited territory over which collecting in this order has been done, it is evident there is much yet to be done in the way of cataloguing the Diptera of the state; so that this list, as well as that of Doctor Snow, published in the Kansas University Science Bulletin, volume II, No. 5, November, 1903, may be considered only a preliminary one.

Family TIPULIDÆ.

Dicranoptycha sobrina O. S.
Common on weeds in the timber the latter part of May.

Erioptera graphica O. S.
Common on weeds in the timber, and also along sloughs, through the month of May. I took several specimens in the house last November and December.

Gnophomyia tristissima O. S.
Common in sweepings from weeds in heavy timber in May.

Pachyrhina punctum Loew.
A common fly on the prairie, especially on the hills and rougher ground during early summer.

Tipula angustipennis Loew.
Common; taken in the timber and in an orchard on the upland the latter part of April.

Tipula trivittata Say.
Among weeds and bushes along creeks the latter part of August.

Family CHIRONOMIDÆ.

Ceratopogon variipennis Coq.
This little chironomid is occasionally taken while milking the cows towards evening, when it may be seen forcing its way among the cows' hair to satisfy its thirst for blood. The one specimen in my collection was taken May 29, 1905.

Family MYCETOPHILIDÆ.

Mycetophila punctata Meig.
The only specimen I have of this species was found under a board lying on the ground in the dooryard March 27, 1903.

Family SIMULIIDÆ.

Simulium venustum Say.

One specimen, taken May 22, 1901.

Simulium vittatum Zett.

This little pest is often abundant the latter part of March and early in April, hovering about and entering horses' and cattle's ears, where it gorges itself on the animals' blood. Last year I found the species quite common as late as November 23.

Family STRATIOMYIDÆ.

Odontomyia (snowi) hieroglyphica Olivier.

Common from early summer until fall, frequenting the flowers of Compositæ.

Pachygaster maculicornis Hine.

I have no specimens of this species in my collection, but in Aldrich's catalogue of North American Diptera this species is credited to Onaga, Kan.; so I suppose a specimen was included among a lot of flies sent by me to Professor Hine.

Family TABANIDÆ.

Tabanus bicolor Wied.

A few specimens of this fly were taken on swampy ground during June. The male was taken frequenting the flowers of Cicuta maculata July 16, 1903.

Tabanus costalis Wied.

This tabanid is common during the hot summer months, attacking cattle and horses.

Tabanus dodgei Whitney.

This fairly common species I have taken only while plowing or listing, when it would be seen flying about the working horses. Occurs only in May.

Tabanus lineola Fabr.

A number of Tabanus which I thought were longus, sent to Professor Hine, of the State University of Ohio, last fall, were mentioned by him in a communication to me as T. lineola.

Tabanus (Tectus) sulcifrons Macq.

This large fly abounds near wooded streams during June and July, where it makes life unendurable to live stock confined in lots near the creeks.

Family LEPTIDÆ.

Cœnomyia furruginea Scopoli.

Some years this fly is quite abundant among the rank growth of weeds in the timber along the creeks during the first part of June.

Xylomyia (Subula) parens Wills.

A specimen was taken in the timber on French creek June 7, another in our orchard on the prairie June 13, and a third specimen was taken in our house May 28.

Chrysopila testaceipes Bigot.

Quite common on the rank herbage in the heavy timber along the larger streams during the month of June.

Family BOMBYLIIDÆ.

Spogostylum œdipus Fabr.
Common about flowers on the prairie during July and August.

Anthrax ceyx Loew.
The only time I have met with this species was on August 16, 1897, when I took a half a dozen or so on the blossoms of a species of Solidago at the edge of the timber along French creek, four miles north of Onaga.

Anthrax sinuosa Wied.
I have taken this on the prairie and in the timber; it occurs from June until August.

Bombylius major Linné.
I have taken this species on blossoms of the apricot from April 13 to April 17.

Family ASILIDÆ.

Leptogaster varipes Loew.
Some years quite common; on the prairies during the latter part of June.

Ospriocerus eutrophus Loew.
This rare and pretty species I have taken in rank grass on the prairie in July.

Ecthodopa pubera Loew.
Occurs from the last of May to the last of August along the larger streams among the weeds in the timber.

Holcocephala abdominalis Say.
Abundant along sloughs, where it frequents flowers growing in such situations. June to July.

Atomosia puella Wied.
Common. I have taken it along sloughs and in the timber along the creeks from June to September.

Ommatius marginellus Fabr.
The two specimens I have of this rare species were taken the first week in July, one in the timber and the other on the prairie.

Erax rapax O. S.
A rather uncommon species; taken on the prairie in September. I have a pair taken *in copula*, and find the sexes differ considerably.

Tolmerus annulipes Macq.
What has been determined as this species was taken in heavy timber early in July.

Family DOLICHOPODIDÆ.

Psilopodinus sipho Say.
Abundant in the timber, where it may be seen disporting itself in the sunlight upon the tops of the weeds. Occurs from the last of May till the last of June.

Diaphorus leucostomus Loew.
One of my notes says: Apparently lapping dew on the leaves of box-elder, May 23. Also taken in sweepings on the grass and weeds in the pasture on the prairie June 24.

Dolichopus scoparius Loew.
I have but one specimen of this species in my collection, which was taken in heavy timber May 17, 1898.

Hybos triplex Walk.
Taken in sweepings on the prairie May 26, 1897.

Hilara femorata Loew.
The one specimen I have of this species was taken May 12, 1901. My notes do not say in what situation, but I think I recollect taking it on the window of our residence.

Rhamphomyia fumosa Loew.
Common on the weeds in the timber during May and June.

Family SYRPHIDÆ.

Microdon fuscipennis Macq.
A single specimen taken about fifteen years ago is all that I have ever seen of this species. The specimen has no date or other labels, as I put no labels on my specimens then.

Mixogaster breviventris Kahl.
A number of uniques given to Professor Kahl while he was yet at the Kansas State University contained a specimen which he determined as this species, but as he retained the specimen, with its accompanying note, I cannot tell when or in what situation it was taken.

Chrysotoxum derivatum Walk.
An uncommon species. Have taken it frequenting flowers along a slough the last week in June; also in heavy timber the last week in August.

Baccha fascipennis Wied.
A few taken in heavy timber the middle of June.

Mallota posticata Fabr.
I have met with this species but once; a half-dozen or so were sunning themselves on the tops of Impatiens pallida on French creek June 12, 1904.

Xylota chalybea Wied.
One of my uniques determined by Professor Kahl. I have a fly taken since, which from memory I think is this species, which was taken May 12, 1901.

Family TACHINIDÆ.

Leskia analis Say.
Taken on weeds in the timber the latter part of July.

Leucostoma senilis Town.
On weeds and bushes in the timber the last week in June, and on the blossoms of Solidago in the pasture the middle of September.

Œstrophasia ochracea Bigot.
Taken on the prairie in September and October. I once found a specimen in water put in a sorghum evaporator over night.

Œstrophasia signifera Van der Wilp.
Taken the last of May.

Ocyptera carolina Desv.
Taken in beating net on the prairie the latter part of June, and on blossoms of Solidago, also on the prairie, early in September.

Acemyia tibialis Coq.
Taken on the prairie June 22, and at light September 22.

Archytas aterrima Desv.

A common species. The only specimens in my collection are among some of my earliest captures in entomology and bear no date or other labels.

Sarcophaga sarraceniæ Riley.

Like the preceding species, my specimens of this bear no date or other labels. A common species.

Cynomia cadaverina Desv.

My remarks on the two preceding species also apply to this.

Myiospila meditabunda Fabr.

Rare. Taken under a piece of cloth placed in the crotch of a tree in the dooryard, to serve as a trap for insects, April 20, 1897.

Ophyra leucostoma Wied.

Taken on Salix longifolia April 25; also taken while maintaining itself in a stationary position on the wing, in the orchard, August 18.

Phorbia acra Walk.

Taken in the orchard April 23; also at the edge of heavy timber along the creek June 16.

Phorbia cinerella Fall.

This little pest, to which I have applied the rather opprobrious epithet of "snot fly," on account of its persistency in trying to fly to one's nose when one is affected with catarrh, is quite common all summer from April on. I once reared a specimen from a pupa found in the shriveled skin of a Geophilus perforans under a stone on the prairie.

Caricea antica Walk.

Found among sweepings made in the orchard April 24; also collected in sweepings made on the prairie May 12.

Family SCATOPHAGIDÆ.

Cordylura gracilipes Loew.

Taken in sweepings in heavy timber in May.

Scatophaga furcata Say.

Common in the timber in July.

Family SCIOMYZIDÆ.

Sciomyza nana Fall.

Beaten from Ambrosia artemisiæfolia October 23, 1897.

Tetanocera arcuata Loew.

A common species; taken in the orchard in April, and in heavy timber in June.

Tetanocera plumosa Loew.

Taken on vegetation growing on swampy ground the middle of June.

Tetanocera saratogensis Fitch.

Common in pastures in May.

Tetanocera umbrarum Linné.

Taken on weeds in a pasture in October.

Family SAPROMYZIDÆ.

Lonchæa rufitarsus Macq.

This species frequents carrion, and my specimens were taken the middle of April.

Palloptera superba Loew.

A rare species. One of the two specimens I have was taken in the timber on a small creek July 7, and the other in the heavy timber on a larger stream July 5.

Sapromyza crevecœuri Coq.

Taken on hazel bushes from the last of June till early in August.

Sapromyza lupulina Fabr.

Taken on weeds in the timber from the last of May till the middle of June.

Sapromyza philadelphica Macq.

Taken on prairie, and on weeds at the edge of timber, during the latter half of June.

Sapromyza vulgaris Fitch.

Swept on the prairie May 30.

Family ORTALIDÆ.

Pyrgota valida Harris.

I have taken this species a number of times in my cloth traps in the trees in the dooryard the latter part of April.

Amphicnephes fasciola Coq.

The types of this species were collected by myself. It is a common species, and is found by beating the vegetation growing in pastures from June until September.

Tritoxa incurva Loew.

One of the uniques determined by Professor Kahl, and my remarks on Mixogaster breviventris (*supra*) also apply to this species.

Pterocalla strigula Loew.

A rare species, and the only specimen I have was taken by sweeping in heavy timber May 18, 1898.

Euxesta notata Wied.

Taken on carrion April 24, and in sweepings in heavy timber May 18.

Family TRYPETIDÆ.

Straussia longipennis Wied.

This species has been listed by Doctor Snow. I have specimens which Professor Hine determines as this species but which I think is a different species, as it is quite different from the form usually known by this name. The wings of my species are narrower than common S. longipennis, and the markings in the wings form a dark band occupying about two-thirds of the costal border of the wing. I feel satisfied that when the species comes to be more thoroughly studied it will be found to be distinct from longipennis.

Eutreta rotundipennis Loew.

On weeds in heavy timber the middle of June.

Eurosta comma Wied.

Taken in fair numbers in a pasture early in October.

Eurosta reticulata Snow.

A rather scarce species. Taken on the prairie May 25, 1900.

Family MICROPEZIDÆ.

Calobata lasciva Fabr.

This common species may be taken in the timber early in June while it disports in the sunlight on the tops of the weeds.

Family SEPSIDÆ.

Prochyliza xanthostoma Walk.

I have taken this species in my sweepings in the orchard from the latter part of April to early in May.

Family PSILIDÆ.

Psila lateralis Loew.

Occurs on vegetation along sloughs and in the timber during the first half of June.

Family EPHYDRIDÆ.

Ochthera mantis DeG.

Common on the wet ground at the edge of a stock pond on my place in June. One specimen I have was swept from the vegetation growing along a slough June 4.

Family OSCINIDÆ.

Chlorops proxima Say.

Swept in a low meadow the latter part of May; also taken on blossoms of Solidago in the pasture September 11.

Hippelates plebejus Loew.

I have taken this species the latter part of June while milking, while it was crawling over the cows, being presumably attracted by the smell of fresh milk.

Family DROSOPHILIDÆ.

Phortica vittata Coq.

One specimen I have was taken May 12, 1901.

Family AGROMYZIDÆ.

Agromyza neptis Loew.

Taken while evidently feeding on the dew on box-elder leaves in the orchard in May, and swept on the prairie June 22.

THE EFFECT OF LIGHT ON MELILOTUS ALBA.

(Sweet Clover.)

By R. W. COPPEDGE, Mulvane.

THE *Melilotus alba*, or Sweet clover, was taken up as an interesting plant to study because it seemed able, to a remarkable degree, to adapt itself to its surroundings. It is one of the earliest plants to appear in the spring, coming up, especially on a south or southeast slope, two or three weeks before any other plant. By the last of March the leaves begin to appear, and on every bright, sunny day the work of forming starch is going on in its laboratories.

By means of its tubercles it is able to extract nitrogen from the atmosphere. We find it, therefore, in great abundance in blue shale and clay soil, where few, if any, other plants can grow.

The readiness with which the leaves and growing stem respond to the light enables the plant to protect itself from heat and cold, and keep its leaves in the best position for forming starch.

Experiments have been made by the author during the months of April and May of 1899 and 1900 to find out, if possible, just how rapid these processes were.

First, as to the nutation of leaves and stems: Kellerman, in his paper read before the Kansas Academy of Science, proved that the *Helianthus annuus* did not nutate, thus disproving popular tradition. He had only worked on plants, however, after anthesis.

Schaffner proved, by a number of experiments conducted in 1896–'97, that prior to anthesis the leaves and flower-heads nutate during the day in such a way as to stand at right angles to the sun's rays. At night the leaves drop, with points turned toward the ground, occupying a sleep position.*

W. P. Wilson and Jesse M. Greenman conducted a number of experiments along the same line on the *Melilotus alba*. Their experiments were to show the regular daily movements of the plant. They found four positions which the leaves take, three normal and one abnormal. The first or normal day position may be seen in the morning or evening. The leaves are spread out, with the blades at right angles to the sun's rays.

In the second or hot-sun position the leaves stand with their tips pointed toward the sun, the blade parallel to the sun's rays.

* Observations on the Nutation of *Helianthus annuus*, Bot. Gaz., vol. 25, pp. 395–404.

In the third or sleep position the leaves sink down, the tips are pointed toward the ground. The two lateral leaflets lie closely against the sides of the terminal leaflet, thus exposing the least possible surface to cold and transpiration.

The fourth position was brought about by covering the plant with red glass. The sleep position was thus modified some, for in this case the leaves, instead of pointing straight down to the ground, were at an angle and pointed toward the base of stem.

The author's results have agreed with Wilson's with one or two slight exceptions. I did not perform the experiment with the red glass, but I have noticed the leaves assume that position when the plants were in pots when first taken up, before the root-hairs had grown out again.

Wilson claimed that it was moisture or transpiration that caused the leaves to assume the hot-sun position. His experiment was as follows: Two potted plants were chosen; one was covered with a bell jar; the other was left standing in the open air. The light was the same in each case. The leaves on the plant in the open assumed the hot-sun position; the leaves on the one under the bell jar did not.

I performed the same experiment several times with potted plants and with plants in the field, without being able to find any difference in the position of the leaves when they were in the saturated atmosphere under the bell jar or in the open air.

A bell jar was placed over a plant in the field at 8:30 A. M. By twelve o'clock the atmosphere under the jar was saturated, as shown by the moisture which ran down the sides of the jar. On comparing the number of leaves which had assumed the hot-sun position with those of a plant standing near by under apparently the same conditions, there was no difference in the number which had turned their tips to the sun.

The same experiment was performed by covering one branch of a plant and leaving the other open to the air, but no difference could be noticed in the number of leaves which assumed the hot-sun position on the two branches.

The angles of a number of leaves were taken after they had taken the hot-sun position, and then a bell jar was placed over the plant. In a few minutes the atmosphere under the jar was saturated, but no drop from the hot-sun position occurred during one hour and thirty minutes, as shown by the angles.

A plant was covered with a bell jar at 8:30 A. M. The air was soon saturated. At eleven o'clock the leaves took up the hot-sun

position. At one o'clock the jar was removed. In a few minutes the blades hung limp on their pulvini, showing that the stomata were all open. The change was so sudden that they were not able to close, as they would under normal conditions. Transpiration went on, therefore, and the leaf had soon given up too much water to stand erect.

Three plants in the open on which measurements had been taken turned their leaves each day, at about eleven o'clock, into the hot-sun position, with angles ranging from eighty-five to ninety degrees, the ground being dry. A heavy rain came on and soaked the soil, and for the next two days the leaves did not take up the hot-sun position, although the temperature was the same, twenty to twenty-three degrees centigrade, and the light strength the same.

A potted plant in the window turned its leaves each day to the light in the hot-sun position. Then the plant was supplied with plenty of water. During the next two days the leaves did not assume the hot-sun position. The temperature in each case was about the same, and the light readings for the second day showed more light than before.

From these experiments the conclusion is that the hot-sun position depends on the amount of moisture in the soil and not on the condition of the atmosphere, and that the opening and closing of the stomata depend on the relative humidity of the atmosphere.

As will be more clearly shown later in the accounts of the experiments, nutation took place in almost the entire stem in the young plant, being most noticeable in the pulvinus and decreasing towards the roots. As the plant grows older the region of nutation grows less and less. The pulvinus is so arranged as to permit the leaf to twist in any direction, so that the blade may stand at almost any angle to its petiole.

The movement originated in the leaf blade and extended from there down the stem. That the leaf was the source of the movement was proven by shading the part below the lamina, when the nutation proceeds the same as before. When the lamina above was shaded between dark papers there was no nutation. This agrees with Schaffner's experiments on *Helianthus*.

A number of experiments were made to find whether the movements of the plants and leaves depend on the light only, or whether they simply had a regular daily movement. A few experiments were sufficient to show that the plants would move in any direction to face the light, and that light alone was the cause of the normal day movements.

Schaffner says that the *Helianthus annuus* begins to nutate toward the east before the morning light could affect it. The *Melilotus alba*, however, moves only when acted upon by light. It will remain constant for days facing one direction if the light comes from that direction. It will change the position of its leaves very quickly if the direction of the incident ray is changed.

After these points were determined, an attempt was made to discover, if possible, the relation existing between the rate of movement and the strength of the light. Several methods were used in these experiments. Some healthy potted plants were placed in the laboratory window. The leaves soon all turned their faces to the light. The pot was then turned half-way round. The leaves then twisted on their pulvini, rose or fell, the stem changed its curve, so that in about thirty minutes to one hour the leaves were all again facing the light.

The easiest movement, judging from the time required, was a twist at the pulvinus. The second was where the leaf merely fell or dropped down. The one requiring the most time was where the leaf had to rise against gravity. This latter movement was accelerated when the leaf was lifted either by the wind or one's finger. This accounts for the sudden jumps which will be seen in the record of the movement of leaves taken when the wind was blowing.

Second method: A box sufficiently large not to touch the plant was taken, one end removed, and the inside lined with dark paper. This was then placed over a plant in the field, with the end left open. The light thus came to the plant from one direction only.

In some experiments the box was left over the plant during the night, facing the west, so that the leaves in the morning faced west. The box was then removed and the morning sun shone on the plant. The leaves quickly faced about to the east. Other experiments were made by placing the box over the plant at eight o'clock A. M., so that the light came from the west. The leaves at this time were all turned to the east, but they turned in a short time to the west.

The same results were secured by letting sunlight fall on the plant from the east at five o'clock in the evening, or by letting the light come from the north at noon. It was found, however, that, if the box was left over a plant for two days, those leaves which were in the dark part of the box, and were therefore not very strongly illuminated, were not able to recover from the sleep position the morning of the third day, even when exposed to the morning sunlight for two hours.

Following is a statement of some of the experiments. The angle of the leaf was measured by means of a goniometer used for determining the height of trees. The light strength was determined by means of a light machine invented by Professor Stevens, of the State University, who took a large number of the readings recorded.

Experiments made on a plant in a window:

EXPERIMENT No. 1.

Temperature, 20° C. Time, 1:30 to 2:00 P. M.
Light readings: Red, 0.372; blue, 0.328; green, 0.89.

	Leaf No. 1.	*Leaf No. 2.*
Dropped	37°	46° and 60°
Rose	5°	17°

EXPERIMENT No. 2.

Temperature, 21° C. Time, 1:00 to 3:00 P. M.
Light readings: Red, 0.605; green, 2.94; blue, 6.432.

	Leaf No. 1.	*Leaf No. 2.*	*Leaf No. 3.*
Time, 30 minutes	19° drop.	18° drop.	15° drop.
25 "	19° "	38° "	20° "
35 "	8° "	11° "	
30 "	27° "		
20 "	14° twist.	16° twist.	
20 "	20° "	30° "	
20 "	35° "	55° "	

EXPERIMENT No. 3.

Temperature, 22° C. Time, April 3, 8:25 A. M.
Light readings: Red, 0.3477; green, 1.404; blue, 3.65.

	Leaf No. 1.	*Leaf No. 2.*
Time, 60 minutes	13°	30°
Petiole of leaf twisted.		
Time, 30 minntes	18°	20°

EXPERIMENT No. 4.

Temperature, 17° C. Time, April 4, 8:55 A. M.
Light readings: Red, 0.295; green, 1; blue, 7.628.

	Leaf No. 1.	*Leaf No. 2.*	*Leaf No. 3.*
Time, 35 minutes	20° drop.	20°	6°
30 "	13° "	12°	9°

Experiments made on a plant in the field (the leaves were turned to the west, because a box had been placed over the plant):

EXPERIMENT No. 1.

Temperature, 18° C. Time, April 26, 8:35 A. M.
Light readings: Red, 8.33; green, 22.75; blue, 43.73; yellow, 13.16.
Leaf rose 8°, fell 18°; stem moved 15° in 15 minutes.

EXPERIMENT No. 2.

Temperature, 23° C. Time, May 7, 9:00 A. M.
Light readings: Red, 1.404; blue, 28.63; green, 4.31.

	Leaf No. 1.	*Leaf No. 2.*	*Leaf No. 3.*	*Leaf No. 4.*
Time, 35 minutes.....	15° drop.	15° drop.	20° drop.	25° twist.
25 "	14° "	13° "	15° "	20° "

EXPERIMENT No. 3.

Temperature, 23° C. Time, May 8, 8:55 A. M.
Light readings: Red, 5.614; green, 50; blue, 10.93.

	Leaf No. 1.	*Leaf No. 2.*	*Stem rose.*	*Stem twist.*
Time, 40 minutes.....	12°	9°	10°	40°
20 "	5°	8°	7°	20°
5 "	4°	4°		
5 "	7°	3°		
10 "	9°			

EXPERIMENT No. 4.

Temperature, 23° C. Time, April 23, 8:35 A. M.
Light readings: Red, 4.31; green, 65.56; blue, 43.73.

	Leaf rose.	*No. 1. Leaf fell.*	*Leaf fell.*
Time, 20 minutes.....	7°	30°	27°
20 "	15°	33°	30°
20 "	10°	20°	
40 "	39°	40°	
5 "	7°		
11 "	11°		
12 "	12°		
13 "	15°		

Twist of petiole, 40° in 40 minutes, and 50° in 50 minutes.
Twist of stem, 8° in 30 minutes, and 9° in 40 minutes.

Some experiments were made to determine the mutual relation of light and carbon dioxide gas in forming starch. They were as follows: Stomata were found on both sides of the leaf in the ratio of fifteen on upper to twelve on lower, under one-quarter objective and one-inch eyepiece.

Leaves of a plant which had been covered over night, and from which all the starch had gone, were treated—one with cocoa-butter on the upper side, one with cocoa-butter on the lower side, one with cocoa-butter on both sides. After several hours, the leaves were examined for starch by cross-sectioning the lamina and treating with chloral hydrate iodine and examined under the microscope. The leaf which had cocoa-butter on the under side was found to have starch grains scattered through all the cells. The one treated with cocoa-butter on the upper side had starch scattered pretty well through all the cells, excepting the long palisade cells on the

upper side. Here the grains were few. The third, which had been treated on both sides, had no starch.

The cocoa-butter was applied by warming it slightly and spreading it in a thin film over the leaf, so as to exclude all carbon dioxide gas. This experiment was performed several times, with the same results.

To be sure the light was not excluded by the cocoa-butter, an experiment was made in the same way by sealing a leaf which contained no starch between two one-inch cover-glasses. The sealing was done by fastening the edges of the cover-glasses together with cocoa-butter or salve, the butter coming in contact with the leaf at the petiole only. Thus all carbon dioxide gas was excluded, but the light had free access. After a few hours, starch was found in the other leaves of the plant but none in those so treated.

On April 12 other leaves without any starch, while yet on the plant, were placed between two squares of dark paper held in place by clasps. Thus light was excluded but air was not. The squares of paper were not as large as the leaf; so part of it was exposed to the light. When examined, starch was found only in the part exposed to the light. The part of the leaf under the black paper had no starch.

On April 29, at six o'clock P. M., some leaves which were full of starch were treated as above with cocoa-butter—some dorsal only, some ventral only, some on both sides; hence, in the latter case, all light was excluded. The next morning all the starch had gone out of all the leaves excepting those treated on both sides. These were full of starch.

On May 2 branches with the leaves full of starch were broken off and placed, at six o'clock P. M., in dark drawers. After sixteen hours the starch had gone from all the cells of the leaves excepting a few of the palisades. Parts of leaves treated in the same way did not lose their starch.

Hence, when air only was present, the starch went out of the leaf, but only when light and air both were present was starch formed

A number of experimnts were performed to determine how long it required, when conditions were favorable, for the plant to form starch.

With the temperature at 20 deg. C., and light readings, red 19, yellow 20, green 20, blue 53.06, starch formed in one hour and thirty minutes. With the temperature 19 deg. C., light readings,

red 1.9, yellow 2.66, green 4, blue 10.40, a cloudy day, starch formed in two hours and fifty minutes.

Later a few spring rains fell, and the new leaves which opened out were of a much lighter green than the old ones. When the temperature was 20 deg. C., and the light readings were, red 19, yellow 20, green 20, blue 56.06, it was found that it took one hour and thirty minutes to form starch in the old leaves, and two hours and thirty minutes in the young leaves.

Comparisons of the amount of light used in the two cases were as follows: Amount of light coming to the plant was, red, 19; yellow, 20; green, 20; blue, 53.06.

Amount of light which passed through dark leaf was, red, 0.1384; yellow, 0. 2647; green, 0.6; blue, none. Amount of light which passed through colorless leaf was, red, 7.826; yellow, 0.9; green, 18.5; blue, 3.

The amount of light reflected from the two leaves was the same in each case, and was as follows: Red, 0.5538; yellow, 1.125; green, 1.5; blue, 1.154.

Hence, from these figures, we get the amount of light used by each leaf in making starch as follows:

	Dark green leaf.	*Yellow new leaf.*
Red	18.3076	10.602
Yellow	18.6103	17.955
Green	17.9	.....
Blue	51.906	48.906

Some experiments were performed to determine at what time in the night the starch left the plant. On the morning of April 14, it having turned cool in the night, the temperature dropped to 10 deg. C. At seven o'clock the leaves showed starch around the sieve-tubes; none in the palisade cells.

April 28 leaves taken every hour during the night were examined. Starch grew gradually less after midnight. It was nearly all gone at four o'clock; all gone at 5:15. Temperature, 20° C.

April 29 leaves picked every hour were examined. There was a gradual decrease of starch after midnight, and at five o'clock no starch was left. Temperature, average, 20° C.

On the morning of the 12th of June similar experiments were made. Although the temperature was much higher at this time, the starch remained later in the leaves, because of the greater abundance the evening before. The leaves examined in April showed scattered grains of starch, while those examined in June showed starch in thick masses crowding all the cells.

The leaves were examined every half-hour, beginning at four o'clock. At this time the cells were crowded with starch, especially around the sieve-tubes. The outer palisade cells, next to the epidermis, showed a decrease of starch. At 4 : 30 most of the starch had gone out of the palisade cells and there was a considerable reduction in all other cells. At five o'clock starch was left only in the sieve-tubes and a little in the cells bordering them. At 5 : 30 all the starch had gone from the leaf. At six o'clock starch began to appear again in the palisade cells.

Thus it will be seen that starch disappeared first from the palisade cells and reappeared there first.

ADDITIONS TO LIST OF KANSAS COLEOPTERA, 1905.

By WARREN KNAUS, McPherson.

DURING the year 1905 fifty-eight species of Coleoptera have been recorded as new to the Kansas list. Those marked "Leconte" and "Horn," without locality, are recorded in descriptions by those writers, but have not been found by local collectors.

148 Calosoma luxatum Say. (Leconte.)
148*a* Calosoma var. striatulum Lec. (Leconte.)
1562 Hydrochus squamifer Lec. Several specimens, Galena, Kan., collected by Ebb Crum.
Agathengis sp. McPherson; two specimens; May.
Cartodera argus Fall. McPherson; one specimen.
3696 Epurea helvola Er. Douglas county. Snow.
Hydnocera knausii Wickh. Three specimens: Belvidere, July; McPherson, October 10; Topeka, June. Smyth.
4252 Drasterius livens Lec. Wilson county and Onaga.
5251 Ernobius granulatus Lec. Bowditch collection.
5266 Oligomerus alternatus Lec. Onaga. Crevecœur.
Petalium seriatum Lec. Salina.
Catorama confusus Fall. Salina and Onaga.
Catorama mutans Fall. Benedict, Wilson county, May.
Catorama vexatum Fall. Recorded from Kansas in Fall's revision of Ptinidæ.
Catorama nigritulum Fall. Onaga, June. Crevecœur.
Catorama angustum Fall. Hamilton county. Snow. Wallace county, July.
Ptilinus lobatus Cas. Salina, and Republican valley south of Superior, Neb., June. Erroneously listed as thoracicus Rand.
Bostrychus cornutus Horn. Topeka, June. E. G. Smyth.
5434 Canthon vigilans Lec. One specimen; McPherson.
Psammodius sp. Topeka; one specimen. E. G. Smyth.
Aphodius knausii Fall. Englewood, June 26; numerous specimens.
Aphodius, sp. near seabriceps Lec. One specimen; Topeka. Smyth.
5550 Aphodius consentaneous Lec. (Horn.)
Cotalpa subcribrata Wickh. Medora and westward.
6100*a* Molorchus corni Hald. One specimen; Topeka. Smyth.
6282 Strangalia acuminata Oliv. Onaga. Crevecœur.
6389 Monohammus marmorator Kirby. One specimen; Topeka. Smyth.
6400 Goes pulverulenta Hald. On catalpa; Topeka. Smyth.
6436 Lepturges signatus Lec. Topeka. Smyth.
6439 Lepturges regularis Lec. Topeka. Smyth.
6497 Oberea quadricallosa Lec. On hackberry, Topeka. Smyth.
6554 Zeugophora varians Cr. (Horn.)
6595 Megalostomis subfasciata Lec. (Horn.)
6761 Metachroma marginalis Cr. (Horn.)

6766 Metachroma lateralis Cr. (Horn.)
10361 Graphops beryllinis Horn. (Horn.)
Phyllobrotica nigritarsus Linell. One specimen; Salina.
6853 Phyllechthrus gentilis Lec. (Horn.)
6868 Luperodes merica Say. (Horn.)
6907 Galerucella decora Say. Onaga, June 26. on Polygonium. Crevecœur.
6922 Hypolampsis mellyi Cr. (Horn.)
6929 Œdionychis lustrans Lec. Medora; one specimen, June.
6946 Œdionychis scalaris Melsh. (Horn.)
Epitrax, sp. near cucumeris Harr. Two specimens; McPherson.
10427 Diphaulaca bicolorata Horn. (Horn.)
7011 Longitarsus subrufus Lec. (Horn.)
10449 Glyptina bicolor Horn. (Horn.)
7044 Chætocnema elongatula Cr. (Horn.)
7047 Chætocnema decipiens Lec. (Horn.)
7059 Psylloides convexior Lec. Douglas county. Snow.
10457 Psylloides elegans Horn. (Horn.)
Tomoxia sp. One specimen; Onaga. Crevecœur.
Dilandius myrmecops Cas. One specimen; McPherson, April.
Trachyphlœus, sp. not described. McPherson, Onaga, and Lawrence.
8241 Calyptillus cryptops Horn. Four specimens; Meade, May.
8461 Macrops delumbis Gyll. McPherson; one specimen.
8565 Brachybamus electus Germ. One specimen; Medora, May.
8843 Ceutorhynchus convexicollis Lec. Two specimens; Meade, May.

COLLECTING INSECTS AT NIGHT.

By ELBERT S. TUCKER, Museum Assistant in Systematic Entomology, University of Kansas, Lawrence.

COLLECTING insects at night is by no means engaged in to the same extent as day collecting, yet night collecting is far from being neglected. Insects in their season abound by night as well as by day, but those which are active at night seldom appear by day, and those that are found in daytime are not generally caught at night, althought a lapping of the two tendencies is evidenced by some common forms which appear only at twilight or dawn. Consequently, two popular distinctions among insects are established by reason of their choice of either daytime or night-time for period of activity, and the terms *diurnal* and *nocturnal* are familiarly applied. Aside from the preference for day work rather than night work in any pursuit, and collecting is no exception in this respect, the inducements for collecting at night are, however, considering the abundance, importance and variety of nocturnal forms, about equal to those attending day collecting. Some collectors assert that discoveries of new species are more certain to reward night work than operations by day; hence the thorough collector needs to divide his time somewhat between day and night.

In contemplating the present scope of entomology, the student becomes impressed by the remarkable number of species now described in our bulky literature, and is apt to believe that about every kind of insect which thrives in our country, or wherever exploration has been conducted, is scientifically known and named, and in many cases renamed, in consequence of which little chance remains for finding new material. This notion cannot endure long in the face of investigation of what forms of insects can be found especially at night. The author can state that as far as his own captures are reported, in regard to some hymenopterous parasites,* more than two species were captured to one old species, and most of them were collected at night in Lawrence. Whether this is an exceptional case or not, the study of other groups collected at same time under the same conditions is needed for the purpose of determining what percentage of new species to old species would constitute an average estimate, particularly in regard to Microdip-

*See article entitled "Notes and Descriptions of Hymenoptera from the Western United States in the Collection of the University of Kansas," by H. L. Viereck, in Transactions Kansas Academy of Science, volume XIX, pp. 264-326.

tera and Microlepidoptera, the chief associates taken with the parasites. Much depends on the extent to which any group has been studied that leaves a chance more or less open for addition of new species; for instance, the beetles are so thoroughly known that any chance of finding new species is comparatively slight, while the Microlepidoptera, Microdiptera and hymenopterous parasites are in lessening proportion imperfectly known, and new species are quite frequently detected.

The enthusiast, indeed, who expects the accomplishment of great possibilities in entomological research within the next few years may claim, further, that the prospect for rich systematic discovery lies in going over the field the second time, to which we are already becoming accustomed, for the purpose of revision, and, in connection, the search for night forms deserves extended recognition, while at any time it presents a hopeful incentive to collect in territory otherwise considered well worked. Really, in spite of the present advanced state of entomological science, the combined knowledge of the insect fauna of our country in general is, perhaps, still regarded by some workers as having progressed but little beyond the superficial stage. In fact, the names of new species are constantly swelling our already crowded lists, and, what is remarkable, discoveries of new species are often made in old-settled localities long familiar to entomologists. Attention has been given principally to the larger forms of insects, while a host of little things, the greater proportion probably being night denizens, doubtless remain unknown everywhere, and all that is needed to disclose them to science is a larger number of diligent workers, both collectors and students.

Not only the beginner in insect study, but the teacher and experienced collector as well, can find instructive diversion combined with healthful recreation in the cool, refreshing, open air of summer nights by devoting part, if not all, of evenings to collecting specimens. Possibly the student may be regularly employed by day in business or trade, especially since many students are obliged to work in summer-time; but in the evenings, when the time is usually one's own, a grand opportunity for acquaintance with our insect neighbors awaits him ready at hand, whether the interested person is situated in country or city. Employment by day, then, no matter how confining it may be, in business or other calling, should not bar a person from making a collection of insects as long as evenings are free, and in this respect entomology has an advantage over other

branches of science in which material cannot be so readily secured at night.

Changes of weather and influence of the moon have a wonderful effect on the movements of insects at night. Warm, damp, dark nights, without perceptible wind, afford the best conditions towards inducing night insects into activity; then they may be noticed in throngs hovering about every exposed light. At other times, when insects do not appear in ordinary numbers at the lights, the principal reasons may be due to a chilliness of the air or to a strong wind, in which cases only few of the stronger and hardier species seem to venture out of their haunts. Even on other occasions, when there is no shining moon, and all conditions are apparently favorable for impelling insects to fly, the collector will sometimes meet with disappointment, and be unable to account for the scarcity of specimens around artificial lights. At such times, as well as when the moon is shining, the collector should direct his attention to other methods of collecting, such as the sweeping of herbage, which can be resorted to particularly on chilly or windy nights; and, in case of moonlight, he should remember to select the shaded portions in thickets, woods, orchards, or parks. A friend with whom I have used the sugar bait relates that he never noticed any difference in collecting whether the moon shone or not; in fact, he paid no regard whatever to either moonlight or dark nights, but went ahead just the same for one night as another. Doubtless the insects prefer to remain in hiding whenever the moon shines, for they are commonly active before the moon rises, if after dark, or should it set before dawn, they stir about somewhat. The suddenness with which good collecting has failed time and again just at the rising of the moon is remarkable.

The practical collector will soon learn to note the conditions presented each night before he starts operations, and so can guide himself in the selection of the proper course to adopt in obtaining the best results. On rainy nights he might open a window or two of his room opposite to the direction of the wind, thereby being shielded from rain and in the path of insects flying against the storm, and there catch whatever comes in to the light; for, in warm weather, such conditions are often extremely favorable towards bringing out the insects. Really there is no time throughout the growing season, whatever the conditions may ordinarily be, but what can be used in one way or another to good advantage in collecting. The difficulty will be to keep up the mounting of the specimens as fast as the collecting is done. Only the novice will re-

quire instruction in regard to the mounting and preservation of specimens; otherwise the subject need not be mentioned here. Directions for mounting, also for preparing a collecting outfit, are usually contained in elementary guides to the study of insects, and a book of this kind should be in the hands of every person interested in insect life.

Several methods, as already referred to, are employed in the collecting of insects at night, one of which is the simple and ever reliable practice of sweeping by means of the net, so commonly followed by day. This method has previously been recommended, particularly for action on moonlight, chilly or windy nights, though the captures will mainly be the smaller kinds of insects, such as minute flies of the order Diptera, parasites of the order Hymenoptera, and tiny moths of the order Lepidoptera, all of which, nevertheless, deserve attention and careful mounting. Among these little creatures new species are probable. The curious fact has often been observed that after sunset myriads of these little insects can be swept from grass or weeds which in the hot sunshine of the day seemed almost destitute of insect life. A few minutes of sweeping is generally sufficient for gathering enough material to keep the collector busy for hours with the mounting. Usually at twilight or later the grass becomes wet with dew; consequently net and specimens get sticky with moisture; but if the poison bottle is lined inside with blotting-paper, a plan which it is advisable to follow at any time, and not too many specimens put in together, there is little danger of injury to them. As a further precaution, strips of soft paper, such as newspaper, can also be placed loosely in the bottle, to absorb moisture and prevent specimens from shifting and rubbing each other or adhering into masses too large for safety while the bottle is carried.

One blessing, perhaps, for which we ought to be thankful, is that only certain small groups of night insects are musical; if all kinds of insects were as noisy as some examples of the Orthoptera, there is no telling whether a person, unless he was deaf, would be able to sleep in the summer-time. A year ago last summer the following appeared in a local paper:

"KATYDID SANG ALL NIGHT.

"The neighbors in the 700 block on Tennessee street have been greatly annoyed for the past week by a katydid. It would sing all night long, and sang so loud that some thought it must be a tree-toad. All attempts to shake it from the tree proved useless. It was caught last night, and could be termed a giant katydid. It

measured about an inch and a quarter long and had a very large body; its wings were immense, It will be a good specimen for one who is collecting insects." (From Lawrence *Journal*, August 4, 1904.)

On inquiring if the specimen could be obtained, it was learned that chickens had eaten it. However, my disappointment was banished a few nights later when a strong rasping noise was heard issuing from a tree which stood near my home, and as the shrill sounds continued all night it was evident that an accommodating specimen of what was wanted had located there for my benefit. A night or two after, when another songster in another tree began calling also, the conclusion was reached that it was time to make an attempt, at least, to capture one or both of the supposed insects. Provided with lighted lantern and poison bottle, one night, the author climbed the tree, a moderate-sized elm, in which the first fiddler was harbored, and located the fellow by his racket. He was a little cautious as my light approached him and stopped his fiddling, but remained within reach, although attempting to conceal himself among leaves on the under side of a branch. With one well-aimed grab he was secured in my hand and soon reposed safely in my poison bottle. However, his comrade in the other tree, a smaller elm, repeatedly evaded me by climbing out on the tips of branches beyond reach and out of sight. The captured specimen was identified as *Cyrtophyllus perspicillatus* Linnæus, and is now the only example of its species in the collection of the University of Kansas.

Some years ago, while living in Colorado Springs, the business of insect collecting was one night unexpectedly forced upon me. A migration of locusts, the Long-winged grasshopper, known as *Dissosteira longipennis* Thomas, was evidently detracted from flight over or near the city by the electric lights, directly after dark one evening, and the streets soon became covered with the living insects. In seeking every source of light, they invaded open places of business faster than they could be cleared away. They were caught in handfuls and flung into pails of scalding water to end their struggles. The sidewalks and street-crossings of several business blocks were covered so thickly that people walking there would crush a mass of bodies underfoot at every step. Next morning the street cleaners carted off dead grasshoppers by the wagon-load, and for fear another invasion might come, the streets were not lighted for several nights afterward. This phenomenon occurred on Thursday evening, July 21, 1898; and the ridiculous part of the affair was

out, "What are catching?" "Insects! What do you catch them for?" "What do you do with the bugs?" and similar questions; while another observer, perhaps, interposes a rude joke. Or a number of boys will suddenly offer their services and pick up every insect that can be found, since many fall on the ground—moths which flutter until their wings are battered or torn beyond recognition, and the commonest kinds of beetles—all of which are promptly presented to the collector with a shout, "Here, mister! here's a bug!" until he is either distracted with importunities and worthless specimens or forced to move to another location and avoid such associates. Two or more persons collecting together with the same interest afford companionship which gives a mutual feeling of relief from arousing undesirable notice which one person would bear alone, but such company is not always possible.

Only net and bottles are needed in visiting lights on the streets. Electric lights are usually hung quite high, though not as high above side streets as on business streets. Rather than carry a long, unwieldly pole as a handle to my net for reaching lights, it is my custom to let the light down as low as desired by releasing the tackle, after the manner of a trimmer; hence, am enabled to reach the hovering insects with my net on an ordinary length of handle. When done with the light, it is raised to usual position. Care should be exercised to keep one or more bottles exclusively for killing moths, which when dead should be turned into a separate bottle for storage; then the collecting bottles can be used for fresh captures, and as the live moths are not allowed to flutter in with the dead specimens, one danger of injury by denuding of wings is avoided.

Sometimes fine specimens may be found on the ground where they alight or fall. The season for favorable collecting at electric lights begins in Lawrence in the first week of May and it may be said to last for fully six months. Whenever a brisk breeze is blowing, insects fly towards the lights on the side facing the wind; as, for instance, if the wind is south, the insects hover in a trail on the north side. The best place for finding insects in greatest numbers at electric lights in Lawrence was found on the river bridge (over the Kansas river), particularly at the south approach, which is somewhat higher than the north end, but whether this slight difference should account for the greater amount of insects appearing at the south end cannot be stated. Here the aquatic neuropteroid forms, such as May-flies and caddice-flies, became most numerous in July and August. The former are very frail insects and cannot

the glass globe of the lantern, over the surface of which they ran actively, but were captured, one at a time. The open mouth of a poison bottle was dexterously placed over a specimen, confining it against the globe of the lantern until it entered the bottle, which was then quickly closed with the cork held ready in the other hand. Two bottles at least are needed by each person engaging in this process; after a specimen is captured, the bottle should be set aside to allow time for the captive to succumb to the deadly fumes and cease struggling; else, if the bottle is opened too soon, the specimen will escape; meanwhile the other bottle is used for catching a specimen, after which it, too, is set aside, and then the first bottle is used again. Such operations often become quite exciting in efforts to catch exceptional specimens or others that were more or less prized. My little daughter was exceedingly entertained, and many times awaited impatiently for the evening to grow dark enough to begin collecting. Although but nine years old, she has developed quite a knowledge of entomology, and can rattle off big technical names that would perplex the average grown person. Moreover, she has no fear in handling live insects, such as the harmless ones, which are often attentively observed, and besides she has learned to pin up specimens after they are dead as neatly and properly as a professional collector can do. Other children, following the examples of their parents, detest the "crawling things," as they are called, usually with fearful, though needless, abhorrence. Thus, what should provide entertainment and instruction even for children is too generally condemned, and much that could be learned from nature in a simple way is lost. On the other hand, influence once started in the right direction often spreads rapidly. Before very long the neighbors' children had acquired outfits similar to what was provided for my little girl, and their combined excursions in daytime made the vicinity a fateful one for unwary insects, especially butterflies.

The stronger the light the more attractive it becomes to insects; consequently, the electric arc lights on the streets of town or city probably draw insects from long distances. However, collecting at night on the streets or at public places brings a person thus engaged more to notice than in day collecting, when the collector can seek the country. But electric lights cannot be forsaken without a lack of valuable specimens, particularly moths. Therefore, the collector is obliged to take a position directly under the glare of a light, where his movements draw the attention of people passing along the sidewalks. Ofttimes an inquisitive spectator will call

out, "What are catching?" "Insects! What do you catch them for?" "What do you do with the bugs?" and similar questions; while another observer, perhaps, interposes a rude joke. Or a number of boys will suddenly offer their services and pick up every insect that can be found, since many fall on the ground—moths which flutter until their wings are battered or torn beyond recognition, and the commonest kinds of beetles—all of which are promptly presented to the collector with a shout, "Here, mister! here's a bug!" until he is either distracted with importunities and worthless specimens or forced to move to another location and avoid such associates. Two or more persons collecting together with the same interest afford companionship which gives a mutual feeling of relief from arousing undesirable notice which one person would bear alone, but such company is not always possible.

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fly far from the water from which they emerge. It is noticed that they always face the wind, whether at rest or in flight, even should they be carried backwards on the wing. Interesting records could be written from observations regarding night insects. Some of these from my notes are as follows:

"July 27.—Slight rain before dark and May-flies were exceptionally thick around the lights. The floor of the bridge was so thickly covered with these insects that their wings gave the effect of snow, while the woodwork along the sides was coated with white molted skins. One kind of May-fly (*Polymitarchys albus* Say), after falling to the floor, seems unable to rise again, and there batters its wings into shreds in the futile endeavor to fly, until too feeble to flutter longer, when it dies from exhaustion. On close examination their legs are found to be rudimentary or aborted, and therefore too weak to enable the insect even to crawl. This kind has been noticed during the entire week."

"July 30.—The very smallest kind of May-flies (*Cœnis diminuta* Walker) are the first to appear at dusk, when they come in great numbers. The larger kinds appear shortly afterwards, and in such multitudes that the electric-light globe soon becomes choked with their bodies, in a mass so densely packed that the light is obscured. At ten o'clock, or soon after, the insects have mostly dispersed."

Remarks to above.—As a rule, good collecting at lights ends about an hour after dark. As soon as darkness settles, the larger insects generally come with a rush to the lights, but they seldom linger in force very late.

"August 1.—On river bridge just after dark. Myriads of small May-flies flying against the wind to the electric light suggested the appearance of a tail to a comet when viewed from a short distance. Very few caddice-flies out."

"August 3.—Insects very thick. The frail White May-fly (*Polymitarchys albus* Say) was more abundant than usual, and multitudes literally lay in a compact bed on the floor of the bridge, vainly flopping their wings to pieces in trying to rise. Their egg-clusters were scattered about thickly among their bodies."

"August 5.—The common kinds of May-flies were nowise as thick as usual. Found more of the Black caddice-flies than ever before in one evening."

"August 10.—Mostly large moths out. The dead bodies of a considerable number of May-flies were seen sticking by the wings in all sorts of positions to the framework of the bridge, where the

live insects had probably been dashed during a rain-storm of the night before and there left to perish helplessly."

"August 11.—May-flies and caddice-flies somewhat scarce."

"September 21.—On the bill-board near the bridge, the caddice-flies were congregated in numbers, and the noise produced by contact of their bodies as they alighted on the paper was like a continual tapping sound, which first drew my attention."

"October 5 and 6.—On bridge each night between eight and nine o'clock. Nights cool, with full moon shining. Insects were more numerous on these moonlight nights than on dark night preceding. Watching carefully for new species of caddice-fly."

(*Remarks to above.*—This new species was first recognized in my material by Prof. V. L. Kellogg, but it was named by Nathan Banks, from specimens sent to him, as *Hydropsyche kansensis.*)

A favorite location for beetles and moths was found at the light in South park. Here the light was frequently lowered. Wherever game is to be found, there the hunter seeks it. We cannot blame some people who, not knowing about an entomologist's business, may express wonder at his strange actions, particularly if on a street corner at night. But when they begin to question your mental condition, you will probably guard your conduct. A certain party asked a friend: "What is the matter with Mr. T.; is he crazy?" The friend, rather astonished at the question, which seemed to be asked in earnest, replied that Mr. T. had always acted all right; at least he had never done anything strange as far as known; therefore, could not account for such an impression. "Well," the party explained, "he acted very queer the other night. He stood near the lamp-post on the opposite corner of the street and waved and jerked his arms in the air, jumped about on the sidewalk, and ran around the lamp-post several times."

The use of traps in which to catch insects at night, by the allurement of light, is an important method receiving but partial attention. The advantage of a trap is such that, after once rigged up for the night, it "works while you sleep." But next day the work will fall on the collector, who has the catch to pin up. Some traps are so constructed that insects may be allured directly into one, in attempts to reach the light placed inside; another form is arranged to catch insects which fall into it after reaching the light that is openly exposed above it. In any case, however, the insects meet death in a poison jar fixed to receive them, and which is usually charged with cyanide of potassium, although other agents for suffocation, as chloroform, for instance, can be applied.

An outfit of the latter kind was taken and used on a collecting trip for the University of Kansas, under direction of Dr. F. H. Snow, in Hamilton and Morton counties, western Kansas, June, 1902. A large street lantern was furnished to supply the light, and the collecting device consisted of a gigantic funnel, made of heavy tin, painted outside, but left bright and smooth inside, and it converged into a receiver, about the size of a large fruit-can, which could be opened by withdrawal of the bottom in order to allow a cyanide jar to be inserted at time of beginning operation for the night, and to be removed and emptied in the following morning. A tripod of rough poles was erected as a support for the funnel, with the lantern hanging directly over its mouth. Our experience in using this outfit has been related in the account of the expedition, published by the author in the *Kansas Farmer* of December 4, 1902, from which the following is quoted:

"Also, every night the large lantern was lighted and the big funnel hung underneath to trap the insects which fell into it. The light from the lantern served to illuminate the camp finely, though only on one night did it pay as an attraction for insects, but at this time its returns were immense, probably due to a lull and change of wind, which afforded the right condition for insects to fly. Moths and beetles appeared in continuous swarms and fluttered in the circle of light, numbers of them falling into the funnel or onto the ground, and the doctor hastily called out all hands to capture them. Care must be exercised always to prevent injury in catching the delicate creatures; but here the great number of beauties which fluttered in sight nearly drove the doctor to distraction for fear their perfect condition would be marred by beating their wings against the sides of the funnel or on the ground as they endeavored to regain their flight. He groaned aloud, as if the sight of so many prizes gave him a pain, being unable to catch every one that he wanted. Really, the party presented a comic, as well as an animated, scene; the effect of the members in prancing around the lights, whirling nets frantically in the air, or in searching the ground for choicest specimens of the fallen hosts, amid a din of excited exclamations, mingled with the doctor's groans, would have afforded an entertainment for an audience. All efforts were fully repaid at last, for the poison bottles became crammed to the limits with the catches, and the whole party was thoroughly tired before the supply showed signs of failing."

I might mention, however, that the camp was located at the

edge of a thicket along the bank of the Arkansas river, a few miles east of the town of Coolidge.

The danger of specimens injuring themselves is quite well prevented in the box-trap, designed on the plan as mentioned for direct entrance to enclosed light. The width of opening into the trap depends on the space allowed between the edges of two inclined panes of glass which guard the front of the trap. They can be set as desired. For Microlepidoptera, the aperture was narrowed so that anything large enough to do damage could not enter with these tiny and extremely delicate moths. The box was made of heavy tin, painted outside to prevent rusting, but left bright within. An oil lamp was placed at the back end, which is partitioned by a pane of glass from the inner chamber, where the insects are allured by the light shining through to the front. In the bottom of the interior an opening is cut to permit the insects to drop into the poison jar, a Mason pint, which is held in place by a screw ring, made by the center being cut out of a cap, thus providing easy attachment or removal of the jar from beneath. The jar should be strongly charged with poison, since it must remain open when in use, and, for this reason, insects do not die as quickly in it as they would in a closed bottle; hence, if fumes become weak, the captures are liable to flutter too long before they die and mar their wings, as well as of others which they beat. In daytime, after being removed and emptied, the jar will regain strength if closed with a tight cap, or it can be used for storage purposes, or, in a pinch, to kill extra large insects. The price of this trap was five dollars complete.

During the past summer, this trap was used on two trips taken for the University of Kansas, under direction of Dr. F. H. Snow—one to Brownsville, Tex., and the other to Douglas, Ariz. Fully 8000 moths and butterflies were collected at the two places, comprising more specimens of the order Lepidoptera than had ever been caught in any season preceding, and the majority of these were Microlepidoptera, which have required months of work for the spreading of their wings. The use of the trap contributed in a great measure towards this successful collecting.

Besides, hand collecting was engaged in to a large extent in camp. At night, a lighted lamp was set on the camp-table placed in front of the tent where the light shone on the canvas drawn behind it, thus presenting an illuminated screen on which the insects settled in numbers, and from which position, they were easily captured directly into poison bottles. The tiniest moths could be

obtained in this manner in the most perfect condition by careful mode of capture—one specimen being caught at a time, when the bottle was set aside until the insect became stupefied; then the specimen was transferred into a stock bottle. Provided with several bottles, a person could work rapidly for hours into the night, and remain comfortably seated at a table, with equipment and specimens before him.

Only one other method for night work remains to be treated of here, and that is the common practice known as "sugaring." It depends on the use of a bait alluring by scent and tempting to the taste. As mentioned, not all night insects come to light. The wood moths, belonging to the genus *Catocala*, for instance, are only rarely caught in any other way than by sugaring. They are found in secluded thickets or thick woods, which are rather lonesome places for night work. Besides for the sake of company, two persons can work together to better advantage than one alone. The bait is commonly made by mixing beer and molasses, or instead of beer vinegar can be used; and the most effective results are obtained when either or both the beer and molasses are stale and strong-smelling. The mixture is smeared by means of a dauber on trunks of trees and stumps, on logs, or even fence-posts, beginning directly after dark, when the course of operations can be selected with the light of an open lantern. But for inspection purposes, after intervals of about fifteen minutes, a dark lantern, or light otherwise shielded from the person carrying it, is required. Moths, beetles and other kinds of insects are found feeding greedily on the mixture by the collector, who approaches cautiously, with his light thrown on the smeared spots before him. Slowly an open poison bottle is pushed towards a specimen, in case it is a moth, until quite close, when it is quickly clapped over the insect, thus confining it within. Keep the bottle pressed against the tree until, at a favorable moment, the free hand can be thrust over the mouth, and then the cork may be carefully inserted as the fingers slide out of the way. Beetles are generally picked up in the fingers by a quick movement and dropped into poison bottles. In all these matters, practice counts for more than instruction.

ADDITIONS TO THE LIST OF KANSAS ARACHNIDA.

By THEO. H. SCHEFFER, Manhattan.

IN his "Preliminary List of Kansas Spiders," published in volume XIX of the Transactions of the Kansas Academy of Science, the writer recorded 100 species taken within the borders of the state, and expressed the desire to double the list in another season's collecting. But forty-three additional species of spiders have been taken, up to date, however. These are listed in the present paper, together with a preliminary report on other groups of the Arachnida represented in our state.

Four species of spiders new to science are described and figured in this paper. Several other single specimens probably represent new species, but it is not the policy of the writer to describe from a single specimen. To merit description, a supposedly new type should be fairly well represented in some locality.

The forty-three species herein listed represent eleven families and twenty-nine genera. Three of the families and seventeen of the genera were not included in the first list. All summed up, then, we have recorded from Kansas 143 species of spiders, representing 16 families and 67 genera.

The illustrations for this paper were by Miss Ella Weeks.

Types of the new species are in the Kansas Agricultural College collection and in the National Museum, at Washington.

ORDER *ARANEIDA.*

Family ATYPIDÆ.

Brachybothrum robustum Simon.

Brachybothrum robustum Simon. Actes Soc. Linn. Bord., vol. 44, p. 7.

Two males from Manhattan, April 5, and an immature female from Delphos, August 5.

Family ULOBORIDÆ.

Uloborus plumipes Lucas.

Uloborus plumipes Lucas. Explor. d'Algerie Anim., art. I, p. 252.

Two females taken in webs with cocoons at Manhattan, July 14. Immature male from St. George, June 6.

Hyptiotes cavatus Hentz.

Cyllopodia cavata Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 466.

The Triangle spider is apparently rare in Kansas. A single specimen was found at Three-Mile Hill, near Manhattan, October 10.

Family THOMISIDÆ.

Xysticus texanus Banks.

Xysticus texanus Banks. Journ. N. Y. Ent. Soc., XII, 1904, p. 112.

Two females of this prettily marked spider in a collection made at Delphos August 5.

Xysticus graminis Emerton.

Xysticus graminis Emerton. Trans. Conn. Acad., VIII, 1892, p. 364.

A male of this species from Manhattan, May 5.

Ebo latithorax Keyserling.

Ebo latithorax Keyserling. Neue Spinn. aus Amer., V, 1883, p. 678.

Adults of this species have not been observed, but the young were taken in considerable numbers in sweeping at Manhattan, October 11.

Philodromus rufus Walckenaer.

Philodromus rufus Walckenaer. Ins. Apt., I, 1837–'47, p. 555.

Several specimens collected at Minneapolis June 30.

Philodromoides, gen. nov.

Cephalothorax low, about as wide as long; head region much narrowed and slightly elevated. Abdomen fully twice as long as wide, very little wider behind than at the base; somewhat pointed at the end; the base projects a short distance over the cephalothorax, and is distinctly notched on the upper side. The sternum and labium are about as in Philodromus. All eyes approximately equal in size; the anterior row much the shorter and slightly recurved; median eyes of this row farther from each other than from the side eyes. Posterior row also recurved; side eyes of this row on larger tubercles than any of the others; median eyes farther from each other than from the side eyes. Ocular quadrangle considerably wider behind; about as wide as long. Clypeus wider than space between anterior median eyes, but not as wide as space between posterior median eyes; obliquely directed forward and downward. Legs long and slender, the second pair longest, the third shortest; the relative lengths are, in their order, second pair, first pair, fourth pair, third pair. The tibiæ of the first and second pairs are set beneath with ten or twelve stout spines arranged in two rows, and the metatarsi are similarly armed with half that number. Weaker spines likewise occur on the other two pairs of legs and on the pedipalps.

Philodromoides prataria, sp. nov. (fig. 10).

FEMALE.—Length, 6 mm.; length and width of cephalothorax, 2 mm.; width of abdomen, 2 mm. Other characters as given in the generic description. A very few short, bristle-like hairs scattered about among the spines on the outer joints of the legs and on the chelicerae and the pedipalps; thickest on the tarsi of the latter.

COLORATION.—Abdomen plain brown above, mottled and streaked with a lighter shade. The four muscle impressions are quite distinct. Cephalothorax rusty brown, lighter at the sides and just back of the head region. Streaks marked by depressed lines radiate from the dorsal groove. The sternum is pale yellow or almost white. The abdomen is lighter beneath than above, and there is a less mottled central region, set off by a row of indistinct dots on either

side. The legs are pale yellow to whitish. The femora, patellæ and tibiæ of all four pairs are marked in front with a longitudinal stripe of black, which becomes neatly obliterated on the metatarsi and tarsi. The corresponding joints of the legs of the third and fourth pairs are similarly marked on the hind border also. The males are somewhat smaller than the females, the abdomen being considerably narrower than the cephalothorax. The legs are more hairy in appearance and the spines less conspicuous than in the female. The color markings are about the same in the two sexes. This species is not uncommon about Manhattan, Kan., in midsummer. Mature males and females were taken in this locality on August 17.

Family CLUBIONIDÆ.

Castaneira crocata Hentz.

Herpyllus crocatus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 457.

Representatives of this species from Wallace, August 20, and from Manhattan, July 29. From its general appearance and movements this spider might, at first sight, be easily mistaken for a velvet ant (mutillid).

Trachelas tranquilla Hentz.

Clubiona tranquilla Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 450.

One female taken in collecting under stones at Lawrence October 8.

Family DRASSIDÆ.

Zelotes decepta Banks.

Prosthesima decepta Banks. Proc. Acad. Nat. Sci. Phila., 1900, p. 531.

A single male specimen from Manhattan, May 5.

Zelotes rufula Banks.

Prosthesima rufula Banks. Proc. Acad. Nat. Sci. Phila., 1892, p. 17.

A single female specimen from Manhattan, May 5.

Melanophora atra Hentz.

Herpyllus ater Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 455.

Two females from Manhattan, May 1.

Gnaphosa sericata Koch.

Herpyllus bicolor Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 456.

One female from Manhattan, July 27.

Family SALTICIDÆ.

Phidippus pius, sp. nov. (figs. 1, 2, 7).

A medium-sized species, rather light in color. One male taken at Manhattan in October and two females in July.

MEASUREMENTS.—Length of female, 9–10 mm. Length of abdomen, 5 mm; width of abdomen, 3 mm. Width of cephalothorax about the same as that of abdomen. The measurements of the male are very approximately the same, except that the abdomen is slightly narrower.

LEGS.—Relative length, female, 4, 1, 2, 3; male, 1, 4, 2, 3. The legs of the first pair are considerably stouter than any of the others. First and second metatarsi set beneath with six stout spines in two rows. Tarsi of same legs with four spines. A few spines, less regularly placed, on the other legs also.

COLORS.—Female pale yellow beneath, without markings. Very much the same above, except for a dark area occupying the ocellar quadrangle and two narrow, dark colored streaks, one on either side of the median line of the abdomen. The latter are not at all distinct on the anterior third of the abdomen. Two or more pairs of white spots dot these dark streaks. The ground color of the male is somewhat darker, shading into orange brown on the cephalothorax and legs. Like the female, the male is unmarked beneath and has, above, the two dark streaks on the abdomen and the dark area on the ocellar quadrangle. The femora and, to a certain extent, the other joints of all the legs are more or less streaked or almost banded with very dark brown. The tips of the tarsi in both sexes are dark. Palpal organs of the male dark except at the tip. Other joints of the palps pale and unmarked. The body and legs of both sexes are sparsely covered with long, silky hairs, with here and there a spine.

Phidippus texanus Banks.

Phidippus texanus Banks. Proc. Ent. Soc. Wash., 1905.

Not uncommon in the late summer and the autumn months. Specimens taken at Englewood and Medora in July, and at Manhattan in October.

Phidippus multiformis Emerton.

Phidippus multiformis Emerton. Trans. Conn. Acad., VIII, 1891, p. 6.

Two females and one male from Manhattan, July 27.

Phidippus montivagus Peckham.

Phidippus montivagus Peckham. Trans. Wis. Acad., XIII, p. 293.

A single specimen, female, from Manhattan, July 14.

Dendryphantes glacialis, sp. nov. (figs. 3, 4, 8).

An average-sized species, conspicuously striped on the abdomen. Two females were taken at Manhattan May 26, and a pair in the glacial region near St. George June 6.

MEASUREMENTS.—Female, 5.5 mm., male, 5 mm. in length. Cephalothorax, 2.5 mm. long, 2 mm. wide.

COLORS.—The cephalothorax of this species is reddish brown, with scattering white hairs thick enough at the sides and on the posterior slope to almost give the appearance of a band or stripe. About the eyes the red-brown is several shades darker. The ground color of the abdomen is dirty white tinged with yellow. Down the median line is a brown stripe, a little the wider in the male. On either side of this stripe is another of the same color and approximate width, curving a little to conform to the lateral border of the abdomen. Still another and wider stripe, not visible from a dorsal view, runs along each side of the abdomen. In the female this stripe is broken into spots or streaks. On the ventral surface there is a narrow median stripe from the genital opening to the spinnerets, and a wider stripe each side of this. The legs and palps are dull yellow tinged with brown, unmarked in the female, but much darker with some appearance of banding in the male. The front row of eyes is curved, with the middle eyes fully twice as large as the lateral, and almost as widely separated as the former and latter.

Dendryphantes militaris Hentz.
Attus militaris Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 201.
Not so common as D. capitatus. Specimens taken at Manhattan in October.

Pellenes cognatus Peckham.
Pellenes cognatus Peckham. Bull. Wis. Nat. Hist. Soc., I, 1901, p. 224.
One specimen, a female, from Arkalon, July 21.

Peckhamia picata Hentz.
Synemosyna picata Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 370.
A pair of these ant-like spiders taken at Manhattan October 10. Neither sex was quite mature.

Mævia vittata Hentz.
Attus vittatus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 360.
Fairly common. Mature specimens taken at St. George June 6, and at Manhattan in October.

Thiodina sylvana Hentz.
Attus sylvanus Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 364.
A male of this species from St. George, June 6.

Wala palmarum Hentz.
Epiblemum palmarum Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 366.
Three males in material collected at Lawrence October 8.

Family ARGIOPIDÆ.

Araneus aculeatus Emerton.
Epeira aculeata Emerton. Bull. U. S. Geol. Surv. Terr., III, 1877, p. 528.
One specimen, a female, from Clark county, June 15.

Araneus trifolium Hentz.
Epeira trifolium Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 471.
This large orb-weaver is represented in the college collection by a single specimen, female, taken at Manhattan August 22.

Araneus displicatus Hentz.
Epeira displicata Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 476.
One male from St. George, June 6.

Araneus mormon Keyserling.
Epeira mormon Keyserling. Die Spin. Am., vol. IV.
A few specimens taken in provision stores of mud-dauber wasps at Meade July 18.

Acacesia foliata Hentz.
Epeira foliata Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 475.
One female taken in sweeping at Lawrence September 8.

Mangora placida Hentz.
Epeira placida Hentz. Jour. Bost. Soc. Nat. Hist., V, 1845, p. 475.
One female from Manhattan, May 2. Several males, lacking one moult of maturity, collected at Lawrence October 10.

Singa nigripes Keyserling.
Singa nigripes Keyserling. Verh. d. z. b. Ges. Wien, 1883, p. 655.
The species is fairly common in some localities. Specimens from St. George, June 6.

Family LYCOSIDÆ.

Lycosa gracilis Banks.

Lycosa gracilis Banks. Proc. Acad. Nat. Sci. Phila., 1892, p. 70.

A male from Manhattan, May 20.

Lycosa punctulata Hentz.

Lycosa punctulata Hentz. Jour. Bost. Soc. Nat. Hist., IV, 1842, p. 390.

A mature female of this moderately large species from Manhattan, October 6.

Lycosa rufiventris Banks.

Lycosa rufiventris Banks. Proc. Acad. Nat. Sci. Phila., 1892, p. 65.

Not uncommon. Specimens taken at Manhattan in October and April.

Lycosa permiana, sp. nov. (figs. 5, 6, 9).

A medium-sized spider, not uncommon in the spring and early summer. It hides among stones at some distance from watercourses.

MEASUREMENTS.—Female, about 15 mm. in length; male, 10-11 mm. Cephalothorax of female, 6 mm. long, 4.5 mm. wide; moderately arched, the highest point being about midway between the posterior eyes and the front of the dark line marking the dorsal groove. First leg, 14 mm.; fourth leg, 18 mm.

COLORS (in alcohol).—The ground color of both sexes is light yellow. In the male the abdomen is streaked and spotted with black above and brown below. In the female the similar markings of the abdomen are brown, both on the dorsal and the ventral surfaces. The ground color of the abdomen in this sex is sometimes more nearly dirty white than yellow. The markings of the cephalothorax are alike in the two sexes—a rich brown on the sides of the head and in the region traversed by the depressed lines radiating from the dorsal groove. The top of the head, or highest portion of the cephalothorax, is yellow. It is marked posteriorly by a pair of brown spots. A dark line marks the dorsal groove. The legs are light yellow, unmarked, but tinged with a suggestion of brown in places, especially on the distal joints. Numerous long, dark spines and a sparse covering of dark hairs tend to obscure the ground color of the legs. The coxæ and the sternum are brownish. The tarsi of the male palps are dark brown. Lycosids of this species collected at Manhattan in April and at Delphos in May. Both sexes mature at this time.

Pardosa texana Banks.

Pardosa texana Banks. Jour. N. Y. Ent. Soc., XII, 1904, p. 115.

One specimen, a female, from Englewood, August 8.

Pardosa milvina Hentz.

Lycosa milvina Hentz. Jour. Bost. Soc. Nat. Hist., IV, 1842, p. 392.

One lycosid of this species from Meade, July 18.

Family AGELENIDÆ.

Cicurina arcuata Keyserling.

Cicurina arcuata Keyserling. Verh. d. z. b. Ges. Wien, 1887, p. 460.

Two specimens, a male and a female, taken at Manhattan, May 5.

Hahnia agilis Keyserling.

Hahnia agilis Keyserling. Verh. d. z. b. Ges. Wien, 1887, p. 465.

One specimen from Manhattan, April 15.

Family MIMETIDÆ.

Mimetus interfector Hentz.

Mimetus interfector Hentz. Jour. Bost. Soc. Nat. Hist., VI, 1850, p. 32.

A female of this species taken in sweeping at Minneapolis June 30.

Family THERIDIIDÆ.

Theridion puncto-sparsum Emerton.

Theridion puncto-sparsum Emerton. Trans. Conn. Acad., VI, 1882, p. 12.

Found occasionally at Manhattan. Specimens taken in July.

Theridion differens Emerton.

Theridion differens Emerton. Trans. Conn. Acad., VI, 1882, p. 9.

One specimen from Manhattan, May 26.

ORDER *SCORPIONIDA.*

Family CENTRURIDÆ.

Centrurus carolinianus Beauvois.

This seems to be the only species in the state. It is common under loose stones in limestone regions, and is less frequently met with under sandstone or loose bark in other localities. Specimens were taken at various times of the year in the following counties: Douglas, Pottawatomie, Riley, Ottawa, Russell, Smith, Clark, Barber, and Morton.

ORDER *PSEUDOSCORPIONIDA.*

Family CHELIFERIDÆ.

Chelifer cancroides Linnæus.

This species is found in almost any part of the United States. We have, in the college collection, specimens from Lawrence, Manhattan, and Sun. Most of them were taken under bark.

ORDER *SOLPUGIDA.*

Family SOLPUGIDÆ.

Eremobates pallipes Say.

These curious arachnids are not uncommon in the western and southwestern parts of the state. They are nocturnal in habit, and during the day are usually found under stones or cattle chips. Specimens have been secured in Wallace, Seward, Clark and Morton counties. But one Kansas species is known.

ORDER *PHALANGIDA.*

Family PHALANGIDÆ.

Liobunum vittatum Say.

Phalangium vittatum Say. Am. Ent., Lec. ed., vol. II, p. 13.

This is the common "daddy-long-legs" found in most parts of the United States. It includes Say's L. dorsatum, the more northerly type of the species. Abundant in the central and eastern portions of the state, but only occasionally met with in western and southwestern Kansas. Specimens from Delphos, Manhattan, and Lawrence, August to October.

Trachyrhinus favosus Wood.

This species supplants L. vittatum in the southwestern part of the state. It frequents the sage-brush particularly, resembling this vegetation so closely in color that the collector is not likely to see it unless it is in motion. One specimen was taken at Manhattan, and numerous others at Englewood, Coldwater, Arkalon, and Sun, July to October.

Mesosoma niger Say.

Phalangium nigrum Say. Am. Ent., Lec. ed., vol. II, p. 14.

One specimen from Manhattan, October 15. Others taken at Sun and Coldwater in the middle of July.

Family COSMETIDÆ.

Cynorta sayii Simon.

Our representative of this family is fairly common in the eastern part of the state. It is the brownish-red phalangid, found singly, or, in the winter, in clusters under loose stones. Specimens collected at various times of the year in the vicinity of Manhattan, St. George, and Lawrence; one specimen from Sun.

EXPLANATION OF FIGURES.

Fig. 1. Phidippus pius. Female × 4.
Fig. 2. Phidippus pius. Male × 4.
Fig. 3. Dendryphantes glacialis. Male × 7.
Fig. 4. Dendryphantes glacialis. Female × 7.
Fig. 5. Lycosa permiana. Male × 3.
Fig. 6. Lycosa permiana. Female × 3.
Fig. 7. Epigynum of Phidippus pius.
Fig. 8. Epigynum of Dendryphantes glacialis.
Fig. 9. Epigynum of Lycosa permiana.
Fig. 10. Philodromoides prataria. Female × 5.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

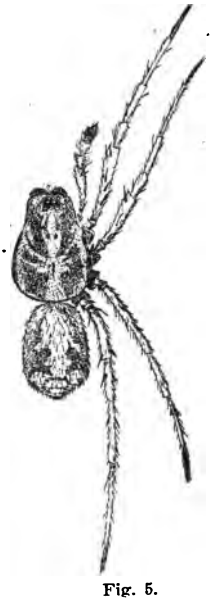

Fig. 5.

Fig. 6.

Fig 7.

Fig. 8

Fig. 9.

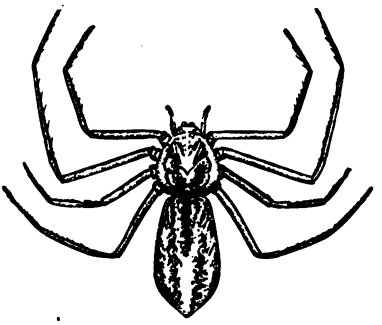

Fig. 10.

THE RED PHALAROPE (Crymophilus fulicarius Linn.) A NEW BIRD FOR THE KANSAS LIST.

By L. L. DYCHE, University of Kansas, Lawrence.

THERE are three species of small shore birds somewhat resembling snipes or sandpipers that belong to the family Phalaropodidæ or phalaropes. The word *phalaropus* means coot-footed (*Phalaris*, the coot, and *pous*, foot). The phalaropes were called coot-footed from the scalloped membrane or flaps on the toes, which resemble those on the coots and grebes.

Wilson's phalarope (*Steganopus tricolor*) is confined during the breeding season to the interior regions of temperate North America. In migration it is said to go as far south as Brazil and Patagonia. It is rather common during the migratory season in Kansas. As a rule, I see a few flocks of these birds every year about the first week in May in the neighborhood of Lakeview, five miles northwest of Lawrence. In June, 1886, Col. N. S. Goss found three pairs of these birds breeding in Meade county. It may be said to breed from southern Kansas north as far as the Saskatchewan regions.

The Northern phalarope (*Phalaropus lobatus*) breeds in boreal regions, but migrates as far south as the tropics in winter. Colonel Goss reports, in his "Birds of Kansas," that he saw a flock of as many as fifteen in Wallace county, Kansas, May 25, 1883. The writer found the birds breeding on the coast of Greenland, and secured specimens at Holsteinborg and Jacobshaven in June, 1895. The nest was a little form in the wet moss near the edge of an ice river.

The Red phalarope (*Crymophilus fulicarius*) belongs to the northern part of the northern hemisphere. It might be described as circumpolar in its distribution. It breeds in the arctic regions north of the sixty-eighth parallel. It migrates south in winter as far as the middle states. I saw specimens at Jacobshaven and Disco island, on the coast of Greenland, in 1895.

A young female Red phalarope was killed at Lakeview, five miles northwest of Lawrence, November 5, 1905, by E. E. Brown, of the University. The bird was flushed from grass and weeds that grew in shallow water. It was the only bird of the kind seen, and, so far as I know, is the first one ever observed in the state of Kansas.

As the Red phalarope is a maritime bird, breeding on the shores of northern bodies of salt water, and spending most of its time on the ocean, its appearance in Kansas was unlooked for. The one taken must, for the present at least, be looked upon as a straggler. It may have been carried out of its usual course by a storm, or may have fallen in company with other birds that go far inland.

In May, 1895, several flocks of phalaropes were seen by the writer, on the ocean between New York and Holsteinborg, Greenland. Many flocks were seen on the return trip, in September, from north of Disco island, to St. Johns, Newfoundland. It was not possible to tell from the ship whether the birds were Red or Northern phalaropes; perhaps both species were seen. Many of them were far out to sea, where no land was visible. They were usually in bunches of from a dozen to perhaps a hundred. They were either flying close to the water, just missing the tops of the waves, or were resting on the water, floating high, as if they possesssed almost no weight.

NOTES ON SOME MOSQUITOES OF DOUGLAS COUNTY.

By CHAUNCEY OVERMAN, University of Kansas, Lawrence.

TOWARDS the latter part of the month of September, 1905, mosquitoes became so exceedingly numerous that the daily papers referred to the "plague of mosquitoes." This condition was due to the excessive rainfall and the warm weather which prevailed throughout the month, conditions favorable to rapid propagation.

At the suggestion of Professor Hunter, several hundred were collected, with a view of ascertaining the proportion of the *Anopheles* or malaria-carrying genus. Of the total number collected, 150 were selected as representative, and were classified. All the specimens were taken within two miles of the University and within about the same distance of the Kansas river. The majority taken were on rather low ground, although they were quite plentiful on the University campus. About twenty per cent. were taken in bedrooms. Most of the collecting was done with a cyanide bottle, although a net was used on a few occasions. The period of collection was from September 20 to December 6.

During the early part of the season the proportion of males was not more than five per cent., but after the first of November it increased to fully thirty per cent. The distribution as to sex was as follows:

Males,	19	12.66 per cent.
Females,	131	87.33 "
Total...	150	100.00 per cent.

Distribution as to genus was as follows:

Anopheles, 21	14 per cent.
Culex, 129	86 "

The number of species was distributed as follows:

Genus CULEX.

C. pipiens Linn., 73	48.66 per cent.
C. sollicitans Walk., 15	10.00 "
C. consobrinus Desv., 13	8.66 "
C. inconspicuous Grossbeck, 7	4.63 "
C. restuans Theob., 5	3.00 "
C. territans Walk., 5	3.00 "
C. melanurus Coq., 4	2.40 "
C. tarsalis Coq., 2	1.20 "
C. perturbans Walk., 2	1.20 "
C. stimulans Walk., 1	.60 "
C. impiger Walk., 1	.60 "
C. signifer Coq., 1	.60 "

Genus ANOPHELES.

A. maculipennis Meig., 3..... 2.00 per cent.
A. punctipennis Say, 18..... 12.00 "

Genus CULEX.

C. pipiens Linn. Fifty-nine males, fourteen females.
This is a medium-sized brown mosquito, and by far the most numerous form in this vicinity. It is found indoors more often than any other. It does not seem to be so susceptible to cold, as it is common several weeks after frost.

C. sollicitans Walk. Twelve females, three males.
A rather large mosquito, with conspicuously banded legs. It is found on high and on low ground and indoors. It is a hard biter, especially after night. It is a quite common species during warm weather, but disappears with frost.

C. inconspicuous Grossbeck. Seven females.
About the size of C. pipiens, but is quite yellowish. Taken on high ground.

C. consobrinus Desv. (C. inornatus Will.) Twelve females.
A brown mosquito, resembling C. pipiens but distinguished from it by the greater length of the petiole of the first submarginal cell. It is much more common on high ground than on low. It is hard to take with a cyanide bottle, and I have never observed it to bite. It is found after frost. C. consobrinus is the same as specimens in the University museum labeled C. inornatus.

C. restuans Theob. Five females.
This mosquito much resembles C. pipiens, but has two white dots on the shoulders. It is described by Smith sometimes as having a U-shaped mark on the posterior portion of the thorax, but I have never observed this. Felt, in Bulletin 79 of New York State Museum, states that the dots on the shoulders are also variable.

C. territans Walk. Three females.
A small, blackish mosquito, with unbanded legs. Found only on low, swampy ground during warm weather.

C. melanurus Coq. Four females.
A medium-sized species, dark brown in color, the segments of the abdomen unbanded or but very slightly at their base. The three posterior segments always unbanded.

C. tarsalis Coq. Two females.
A medium-sized brown mosquito, with banded legs. Taken on University campus early in October. Habits unknown.

C. perturbans Walk. Two females.
A rather small, dark mosquito, the dark scales on the wings giving them a clouded appearance. Taken last week in October. Habits unknown.

C. stimulans Walk. (C. cantans Coq.) One male.
A brown mosquito, having the basal bands of the tarsi very wide. Taken in September.

C. impiger Walk. One male.

A small, dark form. Wings long and narrow. Taken October 15, on swampy ground,

C. signifer Coq. One female.

A medium-sized black mosquito. The shoulders are marked by longitudinal white lines; legs deep black, contrasting sharply with the white bands. Wings covered with about equal number of white and black scales.

Genus ANOPHELES.

A. punctipennis Say. Two males, sixteen females.

The most common malaria mosquito. They were found most abundantly along a ravine, near which was the only house in the city having severe cases of malaria. They are the hardiest species of mosquitoes, being found indoors and on the sunny sides of buildings as late as December 6. The wings are heavily marked with black.

A. maculipennis Meig. Three females.

This mosquito is not at all common. It may be distinguished from A. punctipennis by the wings being almost clear and marked by four distinct black spots.

SOME RESULTS OF THE UNIVERSITY OF KANSAS ENTOMOLOGICAL EXPEDITIONS

To Galveston and Brownsville, Tex., in 1904 and 1905.

By F. H. SNOW, University of Kansas, Lawrence.

THE writer conducted two entomological expeditions to Texas for the museum of the University of Kansas in the years 1904 and 1905. Each of these expeditions had Brownsville, the extreme southern point of the state, as its objective point, but on account of the wretched connections with the one lone steamer between Galveston and our destination, as well as the limited time at our disposal, we spent the three weeks of our first stay, in May, at Galveston, but succeeded in reaching our original destination by rail in 1905, by the new Gulf Coast line. We remained at Brownsville from June 6 to July 8, encamped within a mile of the post-office, beside the estuary, or old bed of the Rio Grande, which forms a part of the dividing line between the United States and Mexico. The entire collecting period of the two trips was seven and a half weeks.

My associates at Galveston were my regular museum assistant, Mr. E. S. Tucker, and a postgraduate student in entomology, Dr. Charles F. Adams, the well-known dipterologist. At Brownsville I was assisted by Mr. Tucker and an undergraduate student, Mr. E. G. Corwine. The success of the two expeditions was largely due to the efficient cooperation of these gentlemen.

This paper contains lists of the species collected in the orders of Lepidoptera, Coleoptera, and Hemiptera-heteroptera. Lists in the other orders of insects will be published at a later date.

I.—LIST OF LEPIDOPTERA.

Grateful acknowledgments are hereby tendered to Dr. Henry Skinner, Prof. John B. Smith and Mr. W. D. Kearfott for important aid in the determination of species.

The numbers and nomenclature are those of Smith's check-list of 1903.

Abbreviations: B. for Brownsville; G. for Galveston.

Family NYMPHALIDÆ.

2 Danais berenice Cram. B.
8*a* Colænis delila Fabr. B.
10 Euptoieta claudia Cram. B.

122 Phyciodes phaon Edw. B. and G.
131 picta Edw. B.
137 Synchloe lacinia Geyer. B.
139 Cystineura amymone Men. B.
160 Junonia cœnia Hbn. B. and G.
164 Eunica monima Cram. B.
171 Timetes chiron Fabr. B.
183 Apatura celtis Bd. & Lec. B.
185 leilia Edw. B.
188 flora Edw. B.
204 Neonympha sosybius Fabr. B.

Family LIBYTHEIDÆ.

255*a* Libythea bachmani Kirtl. B.

Family ERYCINIDÆ.

263 Calephelis cænius Linn. B. and G.
267 Caria melicerta Schaus. B.

Family LYCÆNIDÆ.

283 Thecla melinus Hbn. B.
361 Lycæna couperii Grt. B.
390 hanno Stoll. B. and G.
393 exilis Bdv. G.

Family PAPILIONIDÆ.

402 Pieris monuste Linn. B.
407 protodice Bd. & Lec. B. and G.
409 rapæ Linn. G.
411 Nathalis iole Bdv. G.
438 Colias eurytheme Bdv. G.
446*a* skinneri Barnes. G.
458 Terias lisa Bdv. B.
458*a* alba Strck. B.
459 linda Edw.? B.
479 Papilio polyxenes Fabr. B.
487 thoas Linn. B.

Family HESPERIDÆ.

495*a* Copæodes procris Edw. B. and G.
532*a* Pamphila huron Edw. G.
535 phylæus Dru. B. and G.
536 brettus Bd. & Lec. B.
538 draco Edw. G.
564 errans Skinner. G.
588 osyka Edw. B. and G.
Pyrgus occidentalis Skinner. New species. B. and G.
649 Pholisora catullus Fabr. B and G.
653 hayhurstii Edw. B.
657 Achlyodes thraso Westw. B.

Family SPHINGIDÆ.

921 Ællopos tantalus Linn. B.
729 Deilephila lineata Fabr. G.
755 Phlegethontius carolina Linn. G.

Family CERATOCAMPIDÆ.

829 Adelocephala heiligbrodtii Harv. B.

Family SYNTOMIDÆ.

854 Pseudomya minima Grt. G.
866 Ctenucha venosa Wlk. B.

Family LITHOSIIDÆ.

894 Illice subjecta Wlk. B.

Family ARCTIIDÆ.

930 Eubaphe aurantiaca Hbn. B.
930*a* rubicundaria Hbn. G.
932 Utetheisa bella Linn. G.
950 Estigmene acræa Dru. G.
957 Diacrisia virginica Fabr. G.
994 Apantesis vittata Fabr. G.
996 phalerata Harris. B. and G.

Family AGARISTIDÆ.

1066 Copidryas gloveri G. & R. G.

Family NOCTUIDÆ.

1228 Crambodes talidiformis Gn. B.
1229 Platysenta videns Gn. B. and G.
1253 Caradrina subaquila Harv. B.
1278 Oligia chalcedonia Hbn. B.
1284 nucicolora Gn. B.
1449 Prodenia ornithogalli Gn. G.
1452 Laphygma frugiperda S. & A. G.
1640 Peridroma incivis Gn. B.
1728 Feltia annexa Tr. B. and G.
2164 Leucania subpunctata Harv. G.
2184 juncicola Gn. G.
2502 Heliocheilus paradoxus Grt. G.
2504 Heliothis armiger Hbn. G.
2513 Rhododipsa volupia Fitch. G.
2558 Schinia lynx Gn. G.
2688 Plusiodonta compressipalpis Gn. G.
2711 Autographa pseudogamma Grt. B.
2762 Ogdoconta cinereola Gn. B. and G.
2764 Pæctes declinata Grt. B.
2775 Amyna orbica Morr. B.
2777 Aletia argillacea Hbn. B.
Eucalyptra gigantea Sm. New species. G.
2843 Erastria carneola Gn. B.
2862 Xanthoptera nigrofimbria Gn. B.

2877 Tripudia opipara Hy. Edw. B.
Minofala instans Sm. New species. G.
2884 Metoponia obtusa H.-S. B. and G.
2910 Acontia nuicula Sm. B.
2913 aprica Hbn. B. and G.
2922 cretata G. and R. B.
2933 libedis Sm. B.
2935 candefacta Hbn. B. and G.
2937 Fruva fasciatella Grt. B.
2957 Metathorasa argentilinea Wlk. B.
2971 Parora texana Grt. var.? B.
2973 Homopyralis contracta Wlk. B.
2999 Cænurgia convalesceus Gn. G.
3005 Panula inconstans Gn. B.
3008 Melipotis nigrescens G. & R. B. and G.
3014 versabilis Harv. B.
3015 jucunda Hbn. B.
3020 Cirrhobolina mexicana Behr. B.
3150 Panapoda rufimargo Hbn. B.
3153*a* Remigia marcida Gn. G.
3168 Phurys vinculum Gn. B.
3171 lima Gn. G.
3186 Eubolina impartialis Harv. B.
3187 Campometra amella Gn. B.
3188 bilineata Sm. B.
3190 Heteranassa mima Harv. B.
3205 Yrias repentis Grt. B.
3217*b* Homoptera edusa Dru. B.
strigimacula Du. B.
3274 Tetanolita mynesalis Wlk. B.
3294 Salia interpuncta Grt. B.
Rhescipha snowi Skinner. New species. B.

Family NOTODONTIDÆ.

3364 Datana floridana Graef. G.
3404 Heterocampa bilineata Pack. G.
3424 Harpyia cinerea Wlk. B.
Gonodonta pyrgo Cramer. B.

Family LASIOCAMPIDÆ.

3462 Artace punctistriga Wlk. B.

Family GEOMETRIDÆ.

3743 Hæmatopsis grataria Fabr. G.
3838 Chlorochlamys chloroleucaria Gn. B.
3857 Synchlora denticulata Wlk. B.
3878 Fernaldella fimetaria G. & R. B. and G.
3879 stalachtaria Strck. B.
4102 Tornos scolopacinarius Gn. B.

Family PYROMORPHIDÆ.

Harrisina mexicana Schaus. B.

Family PRYALIDÆ.

4638 Hymenia perspectalis Hbn. G.
4660 Conchylodes platinalis Gn. B. and G.
4687 Diaphania hyalinata Linn. B.
4688 quadristigmalis Grt. G.
4817 Pyrausta phœnicealis Hbn. B.
4826 laticlavia G. & R. G.
4846 Eustixia octonalis Zell. B. and G.
4849 Noctuelia thalialis Wlk. B.
4919 Schœnobius forficellus Thunb. B.
4994 Argyria argentana Martyn. G.

SUMMARY OF FAMILIES AND SPECIES OF LEPIDOPTERA.

Nymphalidæ	14	Lithosiidæ	1
Libytheidæ	1	Arctiidæ	7
Erycinidæ	2	Agaristidæ	1
Lycænidæ	4	Noctuidæ	56
Papilionidæ	11	Notodontidæ	4
Hesperidæ	12	Lasiocampidæ	1
Sphingidæ	3	Geometridæ	6
Ceratocampidæ	1	Pyromorphidæ	1
Syntomidæ	2	Pyralidæ	10

Totals: Families, 18; species, 137.

II.—LIST OF COLEOPTERA.

The author gratefully acknowledges his indebtedness to Mr. Charles Liebeck, Mr. H. C. Fall and Mr. C. Schaeffer for the determination of species not readily identified from the University of Kansas collection.

The numbers are those of Henshaw's lists.

Abbreviations: B. for Brownsville; G. for Galveston.

Family CICINDELIDÆ.

12 Tetracha carolina Linn. B.
38 Cicindela rectilatera Chd. B. and G.
39 tenuisignata Lec. B.
41 tortuosa Dej. B. and G.
42*b* saulcyi Guer. G.
43 hamata Brulle. B. and G.
inquisitor Casey. B.
59 togata Laf. G.
60 pamphila Lec. B. and G.
61 severa Laf. G.

Family CARABIDÆ.

70 Omophron labiatum Fab. G.
127 Calosoma scrutator Fab. B.
129 frigidum Kirby. G.

130 Calosoma sayi Dej. G.
220 Scarites subterraneus Fab. G.
Dyschirius duplicatus? Fall. G.
273 Clivina ferrea Lec. B.
275 bipustulata Fab. B.
295 Panagæus crucigerus Say. G.
311 Bembidium coxendix Say. B.
367 nubiculosum Chd. B.
391 versicolor Lec. B.
394 constrictum Lec. G.
421 lævigatum Say. B.
448 Tachys occultator Casey. G.
479 Pogonus texanus Chd. G.
481 lecontei Horn. B.
563 Pterostichus texanus Lec. B. and G.
564 sayi Brulle. G.
Loxandrus, undet. species. G.
710 Diplochila laticollis Lec. G.
773 Platynus decorus Say. G.
789 collaris Say. G.
805 nutans Say. G.
847 Casnonia pennsylvanica Linn. B.
853 Galerita bicolor Dru. G.
855 Zuphium americanum Dej. B.
860 Thalpius hornii Chd. B.
882 Lebia viridis Say. B.
889 ornata Say. B.
892 analis Dej. B.
897 furcata Lec. B.
913 Blechrus pusio Lec. B.
Euproctus texanus Wickham. B.
917 Tecnophilus croceicollis Men. G.
922 Callida decora Fab. B.
Micragra brunnea Putzeys. B.
960 Helluomorpha texana Lec. B.
961 ferruginea Lec. B.
980 Brachynus puberulus Chd. G.
medius. B.
999 Chlænius orbus Horn. B.
1012 vafer Lec. G.
1022 texanus Horn. B.
1023 perplexus Dej. G.
1059 Agonoderus lineola Fab. G.
1060 infuscatus Dej. G.
1061 pallipes Fab. G.
1064 indistinctus Dej. G.
1066 micros Lec. G.
1083 Harpalus caliginosus Fab. G.
1087 pennsylvanicus De G. G.
1124 Selenophorus palliatus Fab. B. and G.

1126 Selenophorus fatuus Lec. B.
1136 Stenolophus spretus Dej. G.
1146 dissimilis Dej. B.
1176 Anisodactylus piceus Men. G.
1180 rusticus Say. G.
gravidus Lec. G.

Family HALIPLIDÆ.

1226 Haliplus ruficollis De G. B.
Haliplus, new species. B.

Family DYTISCIDÆ.

1240 Hydrocanthus iricolor Say. B.
1249 Laccophilus americanus Aube. B.
1250 terminalis Sharp. B.
1252 4-lineatus Horn. B.
1294 Cœlambus medialis Lec. G.
1401 Copelatus chevrolatii Aube. B. and G.
1480 Hydaticus bimarginatus Say. G.
1495 Thermonectes ornaticollis Aube. B.
1496 basilaris Harr. B. and G.
1496*b* latecinctus Lec. G.
1502 Cybister fimbriolatus Say. B. and G.

Family GYRINIDÆ.

1531 Gyrinus parcus Say. B.
1538 Dineutes emarginatus Say. B.

Family HYDROPHILIDÆ.

1561 Hydrochus variolatus Lec. B.
1587 Hydrophilus insularis Lap. B. and G.
1588 Tropisternus limbalis Lec. B.
1589 dorsalis Br. G.
1595 striolatus Lec. G.
1597 Hydrocharis obtusatus Say. G.
1610 Berosus immaculatus Zimm. B.
1613 infuscatus Lec. B.
1614 striatus Say. G.
1626 Philhydrus nebulosus Say. B.
1657 Creniphilus subcupreus Say. B.
1675 Cercyon prætextatum Say. G.

Family STAPHYLINIDÆ.

2182 Philonthus alumnus Er. B.
var. rufulus Fauvel. B.
2251 Actobius pæderoides Lec. B.
2462 Stenus arculus Er. B. and G.
2492 Cryptobium texanum Lec. G.
2533 Lathrobium seriatum Lec. G.
2543 dimidiatum Say. B.
2585 Pinophilus latipes Grav. G.
2707 Bledius fortis Lec. G.

2709 Bledius brevidens Lec. G.
2717 semiferrugineus Lec. G.
2722 rubiginosus Er. B.
Apocellus, undet. species near sphæricollis Say. B.
Staphylinid, undet. genus and species. B.

Family PHALACRIDÆ.

9877 Olibroporus punctatus Casey?. B.
9879 Acylomus calcaratus Casey. B.
9881 ergoti Casey?. B.
3005 Olibrus apicalis Melsh. B.
Phalacrid, undet. genus and species. B.

Family CORYLOPHIDÆ.

3031 Orthoperus suturalis Lec. B.

Family COCCINELLIDÆ.

3034 Anisosticta seriata Melsh. G.
3036 Megilla fuscilabris Muls. B.
3046 Hippodamia convergens Guer. B.
3064 Cycloneda sanguinea Linn. B.
3065 Olla oculata Fab. B.
3065*a* abdominalis Say. B.
Brachyacantha decora Casey. B.
3142 Scymnus cinctus Lec. B.
3148 collaris Melsh. G.

Family EROTYLIDÆ.

3200 Languria mozardi Lat. B.
3204 angustata Beauv. G.
3205 convexicollis Horn. B.
Dasydactylus cnici Schaeffer. B.

Family CUCUJIDÆ.

3306 Silvanus rectus Lec. B.
3311 Scalidia linearis Lec. B.
Loberus ornatus Schaeffer. B.
3339 Læmophlæus ferrugineus Steph. G.

Family MYCETOPHAGIDÆ.

3409 Typhœa fumata Linn. B.

Family DERMESTIDÆ.

Cryptorhopalum festivum Casey. B.
obesulum Casey. B.
3449 hæmorrhoidale Lec. B.

Family TROGOSITIDÆ.

3838 Tenebrioides corticalis Melsh. B.
3848 Peltis pippingskoeldi Mann. B.

Family PARNIDÆ.

Throscinus schwarzi Schaeffer. B.

Family HETEROCERIDÆ.

3964 Heterocerus mollinus Kies. G.
3965 collaris Wies.? B.
3968 pallidus Say. B. and G.
3969 pusillus Say. B.
10016 schwarzi Horn. G.

Family DASCYLLIDÆ.

4006 Scirtes orbiculatus Fab. B.

Family ELATERIDÆ.

4092 Alaus lusciosus Hope. G.
4135 Esthesopus præditus Horn. B.
4140 Aptopus peregrinus Horn. B.
4182 Monocrepidius aversus Lec. B.
4185 vespertinus Fab. B.
undet. species. G.
4197 Ischiodontus var. oblitus Cand. B.
4250 Drasterius grandicollis Horn. B.
4277 Ludius hepaticus Germ. B.
Glyphonyx, undet. species. B.
4512 Pyrophorus physoderus Germ. B.

Family BUPRESTIDÆ.

4657*a* Chrysobothris analis Lec. B.
10069 edwardsii Horn. B.
4699 Acmæodera pulchella Hbst. B.
4699 pulchella, var. B.
4730 Agrilus lecontei Saund. B.
4755 Taphrocerus gracilus Say. B.
4756 agriloides Cr. B.

Family LAMPYRIDÆ.

4821 Pyropyga minuta Lec. B.
4825 Pyractomena ecostata Lec. G.
4847 Photuris pennsylvanica De G. B.
4872 Chauliognathus scutellaris Lec. B.
4876 marginatus Fab. B.
4973 Lobetus abdominalis Lec. B.

Family MALACHIDÆ.

5007 Collops balteatus Lec. B. and G.
5013 vittatus Say. B.
undet. species. G.

Family CLERIDÆ.

5127 Elasmocerus terminatus Say. B.
californicus Fall. B.
5138 Cymatodera fascifera Lec. B.
5165 Clerus quadrisignatus Say. B.
5173 abruptus Lec. B.

5195 Hydnocera pubescens Lec. B.
Pelonium, new species. B.
maculicolle Schaeffer. B.
5225 Orthopleura var. punctatissimus Chevr. B.

Family PTINIDÆ.

5243 Ptinus bimaculatus Melsh. B.
Catorama ventrale Lec. B.
grande Fall. B.
Sinoxylon, undet. species, probably new. B.
5355 Amphicerus punctipennis Lec. B. and G.
5369 Polycaon obliquus Lec. B.

Family SCARABÆIDÆ.

5439 Canthon perplexus Lec. B.
5442 Chœridium lecontei Harold. B.
5452 Phanæus carnifex Linn. G.
5486 Atænius imbricatus Melsh. G.
5490 oblongus Horn. B.
5491 gracilis Melsh. B.
10185 inops Horn. B.
10190 cognatus Lec. B. and G.
5533 Aphodius lividus Oliv. B. and G.
5560 concavus Say. B.
undet. species. B.
5581 Ochodæus biarmatus Lec. B.
5584 sparsus Lec. B.
Bradycinetus minor Linell. B.
5589 serratus Lec. B.
5591 Bolboceras lazarus Fab. G.
5616 Trox suberosus Fab. B. and G.
5719 Diplotaxis truncatula Lec. B.
undet. species near punctata Lec. B.
5737 Lachnosterna cribrosa Lec. B.
5742 torta Lec. B.
5772 crassissima Blanch. G.
5793 submucida Lec. B.
5797 crinita Burm. B. and G.
10240 dubia Smith. B.
5800 Phytalus robustus Horn. B.
cavifrons Linell. B.
5813 Listrochelus obtusus Lec. B.
5830 Anomala flavipennis Burm. B. and G.
5831 binotata Gyll. B.
binotata, form luteipennis Lec. B.
polychalca Bates. B.
Strigoderma, undet. species. G.
5878 Cyclocephala immaculata Oliv. G.
5767 Chalepus obsoletus Lec. G.
5868 trachypygus Burm. B. and G.

5869 Ligyrus gibbosus De G. G.
5870 ruginasus Lec. B.
5872 rugiceps Lec. G.
5881 Strategus antæus Fab. G.
5883 julianus Burm. B. and G.

Family SPONDYLIDÆ.

5947 Parandra polita Say. B. and G.

Family CERAMBYCIDÆ.

5955 Mallodon serrulatus Lec. G.
5990 Hylotrupes bajulus Linn. G.
6024 Achryson surinamum Linn. B.
6045 Eburia ovicollis Lec. B.
6046 tumida Lec. B.
6047 mutica Lec. B.
6048 manca Lec. B.
Psyrassa texana Schaeffer. B.
6059 Elaphidion inerme Newm. B.
6064 pumilum Newm. G.
6067 Aneflus tenuis Lec. B.
6073 Elaphidion mœstum Lec. B.
Ibidion townsendii Linell. B.
6090 Phyton pallidum Say. B.
Obrium mazinnæ Linell. B.
6106 Ancylocera bicolor Oliv. B.
6119 Dendrobias quadrimaculatus Dup. G.
6163 Stenosphenus novatus Horn. B.
6169 Cyllene crinicornis Chev. B.
6180 Xylotrechus sagittatus Germ. G.
6389 Monohammus marmorator Kirby. G.
6425 Liopus wiltii Horn. B.
6426 crassulus Lec. B.
6433 Dectes spinosus Say. B.
6456 Ecyrus dasycerus Say. B.
6468 Oncideres texana Horn. B.
6471 Ataxia crypta Say. B. and G.
6473 Dorcasta cinerea Horn. B.
6490 Mecas inornata Say. G.
6492 pergrata Say. G.
Aporataxia lineata Hamilton. B.

Family CHRYSOMELIDÆ.

6579 Anomœa laticlavia Forst. G.
6580 mutabilis Lac. B.
6582 Euryscopa lecontei Cr. B.
6588 Coscinoptera canella Lec. B.
6596*a* Babia pulla Lec. B.
6601*b* Chlamys polycocca Lac. B.
6620 Cryptocephalus cribripennis Lec. B.
6622 leucomelas Suffr. B.

6641 Cryptocephalus fulguratus Lec. B.
new species. B.
6649 Griburius scutellaris Fab. B. and G.
6651 montezumæ Suffr. B.
6660 Pachybrachys abdominalis Say. B. and G.
undet. species. B.
Metachroma, undet. species. B.
6707 Diachus auratus Fab. B.
6732 Glyptoscelis crypticus Say, B.
prosopis Schaeffer. B.
6738 Myochrous denticollis Say. B.
magnus Schaeffer. B.
10369 Colaspoides opacicollis Horn. B.
6747 Typophorus canellus Fab. B.
6769 Graphops marcassita Cr. G.
6774 Colaspis brunnea Fab. B.
6791 Doryphora dahlbomi Stal. B.
6800 disrupta Rog. B.
6810*a* bigsbyana Kirby. B.
6839 Lina scripta Fab. B.
6880 Diabrotica connexa Lec. B.
6881*a* tenella Lec. G.
6883 balteata Lec. B.
6885 vittata Fab. B.
6888 longicornis Say. B. and G.
peregrina Jacoby. B.
undet. species. B.
6911 Galeruca integra Lec. G.
6913 maritima Lec. G.
6928 Œdionychis gibbitarsis Say. B.
6929 lustrans Cr. B.
6930 8-maculata Cr. B.
Andrector ruficornis Oliv. B.
6931 Œdionychis interjectionis Cr. B. and G.
6938 petaurista Fab. B. and G.
6949 Disonycha 5-vittata Say. B.
6951 glabrata Fab. B.
6954 abbreviata Melsh. B.
6959 rufa Ill. B.
10416 crenicollis Say. B.
10418 varicornis Horn. B.
6960 Haltica bimarginata Say. B.
6963 ignita Ill. B.
6971 foliacea Lec. G.
undet. species. B.
10438 Longitarsus vanus Horn. G.
Epitrix, undet. species. B.
6980 Crepidodera helxines Linn. B.
two undet. species. B.
Plectroteta flexicaulis Schaeffer. B.

7000 Systena elongata Fab. B.
7087 Charistena bicolor Smith? or new species. B.
7104 Coptocycla guttata Oliv. B.
7107 clavata Fab. B.
7109 Chelymorpha var. 17-punctata Say. G.

Family BRUCHIDÆ.

7126 Bruchus ramicornis Boh. G.
7128 bivulneratus Horn. B.
7129 cruentatus Horn. G.
7131 discolor Horn. G.
7142 uniformis Lec. B.
7145 perforatus Horn. G.
7149 amicus Horn. B. and G.
texanus Schaeffer. B.

Family TENEBRIONIDÆ.

Eurymetopon?, undet. species. B.
7190 Emmenastus texanus Lec. B.
7201 Epitragus acutus Lec. B.
7391 Nyctobates pennsylvanica De G. B.
Eleodes, undet. species near extricata Say. B.
7416 Tenebrio obscurus Fab. G.
7426 Opatrinus aciculatus Lec. G.
Blapstinus, undet. species. G.
7434 fortis Lec. G.
10603 arenarius Casey. B.
Paratenetus, undet. species. G.
7567 Helops perforatus Horn. B.
Strongylium varians Champ. B.

Family CISTELIDÆ.

7589 Allecula punctulata Melsh. B.
Hymenorus, undet. species. B.
10638 Lystronichus piliferus Champ. B.
Lobopoda punctulata. B.

Family LAGRIIDÆ.

Statira simulans Schaeffer. B.

Family MELANDRYIDÆ.

Polypria crux-rufa Chev. B.

Family ŒDEMERIDÆ.

7733 Nacerdes melanura Linn. G.
7735 Xanthochroa trinotata Lec. G.
7739 Oxacis cana Lec. B.
7748 dorsalis Melsh. G.

Family MORDELLIDÆ.

Anaspis, undet. species. B.
7782 Mordella octopunctata Fab. G.
7783 marginata Melsh. B.

7793 Glipodes sericans Melsh. B.
7816 Mordellistena comata Lec. G.
7839 pustulata Melsh. B.
new species. G.

Family ANTHICIDÆ.

Stereopalpus impressicollis?. B.
7938 Anthicus tenuis Lec. B.
7946 vicinis Laf. B.
7960 punctulatus Lec. B.

Family MELOIDÆ.

8045 Gnathium texanum Horn. B.
8050 Zonitis longicornis Horn. B.
8079 Epicauta trichrus Pall. G.
8094 lemniscata Fab. B.
8111 Pyrota dubitabilis Horn. B.

Family OTIORHYNCHIDÆ.

8312 Tanymecus confertus Gyll. B.
Pandeletejus, undet. species. B.
8316 Compsus auricephalus Say. B and G.
Cyphus, undet. species. B.
Pseudocyphus flexicaulis Schaeffer. B.
8338 Coleocerus marmoratus Horn. B.
8340 Eudiagogus pulcher Fah. B. and G.

Family CURCULIONIDÆ.

8347 Sitones flavescens Marsh. B.
Apion, undet. species. B.
8549 Smicronyx corpulentus Lec. B.
Pachyphanes, undet. species. B.
8570 Endalus setosus Lec. B.
10975 Anthonomus leucostictus Dietz. B.
10985 grandis Boh. B.
Tychius, three undet. species. B.
Otidocephalus, undet. species. B.
8711 Læmosaccus plagiatus Fab. B.
8716 Conotrachelus seniculus Lec. B.
8725 similis Boh. B.
8741 Rhyssematus palmacollis Say. B.
8745 pruinosus Boh. B.
Chalcodermus serripes Fab. B.
8812 Copturus nanulus Lec. G.
8814 adspersus Lec. B.
Cœliodes tarsalis ——. G.
8829 tenuipes Lec. B.
8879 Baris ærea Boh. B.
undet. species. B.
Nicentrus, undet. species. G.
11142 Madarellus cuneatus Casey. B.

11191 Limnobaris ebena? Casey. B.
8952 Barilepton lineare Lec. B.
Barinids, two undet. genera and species. B.
Barinus albescens. B.

Family BRENTHIDÆ.

8966 Cylas formicarius Fab. B.

Family CALANDRIDÆ.

8978 Rhodobænus tredecimpunctatus Ill. G.
8984 Sphenophorus ochreus Lec. G.
8998 placidus Say. G.
9011 Calandra oryzæ Linn. B.
9032 Allomimus dubius Horn. B.

Family ANTHRIBIDÆ.

9218 Anthribus cornutus Say. B.
9227 Brachytarsus vestitus Lec. B. and G.
undet. species. G.

SUMMARY OF FAMILIES AND SPECIES OF COLEOPTERA.

Cicindelidæ	10	Malachidæ	3
Carabidæ	59	Cleridæ	9
Haliplidæ	2	Ptinidæ	6
Dytiscidæ	11	Scarabæidæ	41
Gyrinidæ	2	Spondylidæ	1
Hydrophilidæ	12	Cerambycidæ	31
Staphylinidæ	14	Chrysomelidæ	64
Phalacridæ	5	Bruchidæ	8
Corylophidæ	1	Tenebrionidæ	13
Coccinellidæ	9	Cistelidæ	4
Erotylidæ	4	Lagriidæ	1
Cucujidæ	4	Melandryidæ	1
Mycetophagidæ	1	Œdemeridæ	4
Dermestidæ	3	Mordellidæ	7
Trogositidæ	2	Anthicidæ	4
Parnidæ	1	Meloidæ	5
Heteroceridæ	5	Otiorhynchidæ	7
Dascyllidæ	1	Curculionidæ	30
Elateridæ	11	Brenthidæ	1
Buprestidæ	7	Calandridæ	5
Lampyridæ	6	Anthribidæ	3

Totals: Families, 42; species, 418.

III.—LIST OF HEMIPTERA-HETEROPTERA.

For invaluable aid in the determination of species the author is indebted to Messrs. E. P. Van Duzee and Otto Heidemann.

The numbers are those of Uhler's check-list.

Abbreviations: B. for Brownsville; G. for Galveston.

Family SCUTELLERIDÆ.

26 Homæmus proteus Stal. B.
26 proteus, var. B.

Family CORIMELÆNIDÆ.

59 Corimelæna pulicaria Germ. B. and G.
61 unicolor Pal. Beauv. G.

Family CYDNIDÆ.

79 Homaloporus pangæiformis Sign., probably. B.
103 Pangæus bilineatus Say. B.

Family PENTATOMIDÆ.

174 Podisus acutissimus Stal. B.
190 Brochymena quadripustulata Fab. B.
192 obscura H. Schf. B.
226 Œbalus pugnax Fab. B. and G.
237 Mormidea sordidula Stal. B.
247 Euschistus servus Say. G.
253 bifibulus Pal. Beauv. B.
256 comptus Walk. B. and G.
271 Proxys punctulatus Pal. Beauv. G.
300 Thyanta custator Fab. B.
324 Runibia proxima Dallas. B.
334 Nezara viridula Linn. G.
347 Banasa imbuta Walk. B.

Family COREIDÆ.

425 Chariesterus albiventris Burm. B.
cuspidatus Dist. B.
447 Mozena lunata Burm. B.
479 Acanthocephala declivis Say. B.
482 granulosus Dallas. B.
491 Leptoglossus phyllopus Linn. B. and G.
503 Pthia picta Drury. B.
518 Catorhintha texana Stal. B.
522 Anasa tristis De G. G.
524 andresii Guer. B.
560 Hyalymenus tarsatus Fab. B.
571 Stachyocnemus apicalis Dallas. B.
Cydamus borealis Dist. B.
573 Darmistus subvittatus Stal. B.
585 Harmostes serratus Fab. B.
586 near nebulosus Stal. B.
587 virescens Dallas. B.

595 Corizus hyalinus Fab. B.
601 lateralis Say. B.
602 punctipennis Dallas. B.
604 nigristernum Sign. B.
new species.
608 Jadera hæmatoloma H. Schf. G.

Family LYGÆIDÆ.

618 Nysius californicus Stal. B.
providus Uhl. B.
628 Cymus angustatus Stal. G.
Ischnodemus, near fulvipes De G. G.
639 Geocoris pallens Stal. B. and G.
661 Ligyrocoris constrictus Say. G.
Perigenes, undet. species. B.
668 Pamera longula Dallas. B. and G.
671 bilobata Say. B.
undet. species. B.
674 basalis Dallas. B.
684 Ptochiomera oblonga Stal. B.
733 Lygæus lineola Dallas. B. and G.
743 bicolor H. Schf. B.
759 Oncopeltus Dallas. B. and G.

Family LARGIDÆ.

766 Largus succinctus Linn. B. and G.
774 Dysdercus mimus Say. B.
777 concinnus Stal. B.

Family CAPSIDÆ.

790 Trigonotylus pulcher Reut. B. and G.
Creontiades signatus Dist.? B.
Pallacocoris, near jurgionus Stal. B.
819 Resthenia insignis Say. B.
840 Oncerometopus nigriclavus Reut. B.
Hadrodema pulverulentum Uhl. B.
892 Lygus distanti Atkinson. B.
847 Phytocoris eximius Reut. B.
854 Neurocolpus nubilus Say. B.
860 Calocoris rapidus Say. B.
Megacœlum pusillum Uhl. B.
catullum Uhl. B.
881 Lygus pratensis Linn. G.
884 carolinæ Reut. B. and G.
888 sallei Stal. B.
902 Pœciloscytus basalis Reut. B.
Pœcilocapsus, new species. B.
944 Pycnoderes insignis Reut. G.
994 Episcopus ornatus Reut. B.
998 Atomoscelis seriatus Reut. B.
999 Agalliastes suavis Reut. G.

Family ANTHOCORIDÆ.

1035 Triphleps insidiosus Say. G.

Family TINGITIDÆ.

1050 Piesma cinerea Say. B.
1056 Corythuca decens Stal. G.

Family PHYMATIDÆ.

1118 Phymata erosa Linn. G.

Family NABIDÆ.

1135 Phorticus collaris Stal. B.
1144 Coriscus ferus Linn. G.
undet. species near ferus L. B.

Family REDUVIIDÆ.

1152 Sinea diadema Fab. G.
1153 coronata Stal. B.
1168 Rocconata annulicornis Stal. B.
1172 Atrachelus cinereus Fab. B. and G.
1178 Repipta taurus Fab. B.
1209 Pindus socius Uhl. B.
Apiomerus spissipes Say. B. and G.
1231 Rasahus biguttatus Say. B.
1237 Melanolestes abdominalis H. Schf. B.
1247 Conorhinus rubro-fasciatus De G. B.
1267 Pnirontis infirma Stal. B.
1269 Pygolampis pectoralis Say. G.
1273 Oncocephalus geniculatus Stal.

Family EMESIDÆ.

1285 Emesa, near fratera Say. B.

Family GERRIDÆ.

1305 Limnotrecthus marginatus Say. B. and G.

Family VELIIDÆ.

Mesovelia mulsanti B. White. B.

Family SALDIDÆ.

1327 Salda signoretii Guer. G.
1331 sphacelata Uhl. B. and G.
1344 pallipes Fab. G.
vagator Uhl., MS. G.

Family BELOSTOMATIDÆ.

1380 Belostoma americanum Leidy. G.
1385 Benacus griseus Say. B. and G.

Family NEPIDÆ.

1396 Ranatra quadridentata Stal. B.

Family NOTONECTIDÆ.

1408 Buenoa platycnemis Fieb. B. and G.

Family CORIXIDÆ.

Corixa, five undet. species. B. and G.

SUMMARY OF FAMILIES AND SPECIES.

Scutelleridæ	2	Nabidæ	3
Corimelænidæ	2	Reduviidæ	13
Cydnidæ	2	Emesidæ	1
Pentatomidæ	13	Gerridæ	1
Coreidæ	23	Veliidæ	1
Lygæidæ	15	Saldidæ	4
Largidæ	3	Belostomatidæ	2
Capsidæ	21	Nepidæ	1
Anthocoridæ	1	Notonectidæ	1
Tingitidæ	2	Corixidæ	5
Phymatidæ	1		

Totals: Families, 21; species, 117.

SOME RESULTS OF THE UNIVERSITY OF KANSAS ENTOMOLOGICAL EXPEDITIONS TO ARIZONA in 1904 and 1905.

By F. H. SNOW, University of Kansas, Lawrence.

THE expedition of 1904 made its headquarters at Thomas's ranch, in Oak Creek canyon, twenty miles southwest of Flagstaff, in Coconino county, 6000 feet above sea-level, the locality visited in 1902. My associates were Prof. W. H. Johnson and two students, Messrs. Eugene Smyth and Judah Drisko. Our collecting continued for seven weeks, from July 16 to September 2.

The expedition of 1905 made camp on the San Bernardino ranch, in the valley of Sycamore creek, between the Perilla mountains and the Peloncillo mountains, eighteen miles east of Douglas, in Cochise county, in the southeast corner of Arizona, and close to the United States and Mexico boundary line. This ranch is an oasis in the desert, and its proprietor, Mr. J. H. Slaughter, and his estimable wife and family rendered us many valuable services. Our tents were pitched in close proximity to a flowing artesian well, about three quarters of a mile from the ranch houses and within a quarter of a mile of the spot where the Apache chieftain, Geronimo, gave up his arms. The altitude of our camp was about 3750 feet above sea-level. My assistants on this trip were three students, Messrs. Eugene Smyth, Ebb Crumb, and Rollin Perkins, and I have never had a more indefatigable corps of collectors. Our collecting period included five weeks, from July 30 to September 2, making a total of twelve weeks of field-work for the species enumerated in these lists.

I.—LIST OF LEPIDOPTERA.

For invaluable aid in the determination of species not readily determined from the University of Kansas collection, the author is indebted to Dr. Henry Skinner and Prof. John B. Smith.

The numbers and nomenclature are those of Smith's check-list of 1903.

Abbreviations: S. for San Bernardino ranch; O. for Oak Creek canyon.

Family NYMPHALIDÆ.

1 Danais plexippus Linn. S. and O.
2 berenice Cram. O.
2*a* strigosa Bates. S. and O.

15 Argynnis nitocris Edw. O.
20 nausicaa Edw. O.
103 Melitæa chara Edw. S.
127 Phyciodes camillus Edw. S. and O.
128 mylitta Edw. O.
131 picta Edw. S.
137*a* Synchlœ crocale Edw. S.
157 Pyrameis huntera Fabr. O.
158 cardui Linn. S. and O.
169 Timetes petreus Cram. S.
175*a* Limenitis arizonensis Edw. O.
177 wiedemeyerii Edw. O.
180 obsoleta Edw. S.
182*a* Heterochroa californica Butl. O.
200 Neonympha henshawi Edw. O.
205 rubricata Edw. O.
228*e* Satyrus olympus Edw. O.
231 meadii Edw. O.
251 Chionobas œno Bdv. S.

Family LIBYTHEIDÆ.

255*a* Libythea bachmani Kirtl. S.

Family ERYCINIDÆ.

260 Lemonias nais Edw. O.
261 palmerii Edw. S.
264 Calephelis borealis G. & R. S.

Family LYCÆNIDÆ.

271 Thecla crysalus Edw. O.
285 californica Edw. O.
311 leda Edw. S.
323 apama Edw. O.
325 læta Edw. O.
356 Lycæna phileros Bdv. O.
360*b* mertila Edw. O.
383*f* arizonensis Edw. O.
383*g* neglecta Edw. O.
384*a* herrii Grinnell. O.
385 comyntas Godt. O.
387 isola Reak. S.
390 hanno Stoll. O.
393 exilis Bdv. O.
394 marina Reak. O.

Family PAPILIONIDÆ.

398*a* Neophasia suffusa Stretch. O.
407 Pieris protodice Bd. & Lec. S.
411*a* Nathalis irene Fitch. S. and O.
423 Catopsilia eubule Linn. S.
433 Colias cæsonia Stoll. S.
438 eurytheme Bdv. S. and O.

454 Terias nicippe Cram. S. and O.
469 Papilio philenor Linn. S.
479 polyxenes Fabr. S.

Family HESPERIDÆ.

495*a* Copæodes procris Edw. O.
506 Pamphila taxiles Edw. O.
535 phylæus Dru. S. and O.
551 vestris Bdv. O.
559 lunus Edw. O.
565 ethlius Cram. S.
592 fusca G. & R. O.
600 Amblyscirtes nysa Edw. S.
604 ænus Edw. O.
607 nanno Edw. O.
613 Pyrgus occidentalis Skinner. New species. S. and O.
627 Nisoniades ausonius Lint. O.
631 petronius Lint. O.
638 pacuvius Lint. O.
641 funeralis Scud. & Burg. O.
649 Pholisora catullus Fabr. S.
651 pirus Edw. O.
691 Erycides amyntas Fabr. S.

Family SPHINGIDÆ.

702 Hemaris thetis Bdv. O.
729 Deilephila lineata Fabr. S. and O.
737 Pholus achemon Dru. O.
754 Phlegethontius quinquemaculata Haw. O.
766 Sphinx chersis Hbn., form oreodaphne Hy. Edw. O.
788*a* Marumba occidentalis Hy. Edw. S.

Family SATURNIIDÆ.

814 Agapema galbina Clem. S.
821 Coloradia pandora Blake. S.

Family SYNTOMIDÆ.

Cosmosoma rubrigutta Skinner. New species. S.
859 Scepsis fulvicollis Hbn. S.
866 Ctenucha venosa Wlk. S.

Family LITHOSIIDÆ.

Ruscino arida Skinner. New species. S.

Family NOLIDÆ.

909 Rœselia fuscula Grt. O.

Family ARCTIIDÆ.

926 Eubaphe ostenta Hy. Edw. O.
950 Estigmene acræa Dru. O.
955 Hyphantria textor Harr. S.
984 Apantesis proxima Guer. S.
1005 Euchætias murina Stretch. S.

1020 Euverna clio Pack. O.
1034 Euschausia ingens Hy. Edw. O.
1038 Eupseudosoma involutum Sepp. S.

Family AGARISTIDÆ.

1066 Copidryas gloveri G. & R.

Family NOCTUIDÆ.

1243 Caradrina meralis Morr. O.
Cyathassa, new species. S.
1329 Hadena perpensa Grt. O.
1444 Pyrophila pyramidoides Linn. O.
1459 Pseudanarta flavidens Grt. O.
1478 Oncocnemis aurea Grt. S.
1553 Aleptina inca Dyar. S.
1562 Rhynchagrotis variata Grt. O.
1639*a* Peridroma saucia Hbn. O.
1647 Noctua smithii Snell. O.
1655 c-nigrum Linn. O.
1717 Feltia herilis Grt. O.
1867 Euxoa atropulverea Sm. O.
1888 insulsa Wlk. O.
1895 intrusa Sm. O.
1900 basalis Grt. O.
1922 redimicula Morr. O.
2003 Mamestra trifolii Rott. S.
Barathra antonito Barnes. O.
2194 Leucania farcta Grt. O.
2226 Tæniocampa perforata Grt. S.
2231 incincta Morr. O.
2251 planalis Grt. O.
2268 Tricholita inconspicua Grt. S.
2334 Cucullia speyeri Lint. S.
2474*a* Calymnia calami Harv. O.
2448 Trichocosmia inornata Grt. S.
2502 Heliocheilus paradoxus Grt. S.
2504 Heliothis armiger Hbn. S. and O.
2530 Schinia conchula Feld. S.
2558 lynx Gn. S.
2569 arcifera Gn. O.
2596 Lygranthœcia siren Strck. S. and O.
2641 Fenaria sevorsa Grt. O.
Grotella binda Barnes. S.
Antaplaga hachita Barnes. S.
2659 Bessula luxa Grt. S.
2661 Narthecophora pulverea Sm. S.
2667 Stibadium spumosum Grt. S.
gloriosum. S.
2672 Cirrhophanus dyari Ckll. S.
Stiria aliago Barnes. S.
2683 Basilodes chrysopis Grt. S.

2810 Autographa californica Speyer. S. and O.
2720 brassicæ Riley. S. and O.
2752 Plusia accurata Hy. Edw.? S.
Minofala instans Sm. New species. O.
2842 Erastria propera Grt. S.
2851 Azenia implora Grt. S.
2852 edentata Grt. S.
2871 Thalpochares fortunata Grt. S.
2886 Metoponia macula Sm. S.
2892 Tornacontia tripartita Sm. S.
2893 altera Sm. S.
2895 Therasea angustipennis Grt. S.
2905 Acontia expolita Grt. S.
2907 niveicollis Sm. S.
2908 gonella Strck. S.
2914 areli Strck. S.
2922 cretata G. & R. S.
2924 elegantula Harv. S.
2933 libedis Sm. S.
2937 Fruva fasciatella Grt. S.
2950 Spragueia funeralis Grt. S.
2953 tortricina Zell. S.
Cissusa, new species. S.
Homopyralis cinctus Sm. New species. O.
3003 Euclidia dyari Sm. S.
3008 Melipotis nigrescens G. & R. O.
3020 Cirrhobolina mexicana Behr. S.
3021 vulpina Hy. Edw. S.
3085 Catocala aholibah Strck. O.
3092 mariana Hy. Edw. O.
3122 subnata Grt. O.
3143 Toxocampa victoria Grt. O.
3192 Heteranassa minor Sm. S.
3198 Matigramma rubrosuffusa Grt. S.
3202 Yrias clientis Grt. S.
3260 Zanclognatha ochreipennis Grt. O.
Renia rigida Sm. New species. O.

Family LASIOCAMPIDÆ.

3467 Tolype brevicrista Dyar. S.

Family GEOMETRIDÆ.

3707 Emplocia inconstans Geyer. O.
3878 Fernaldella fimetaria G. & R. S.
3879 stalachtaria Strck. S.
3493*a* Sciagraphia trifasciata Pack. O.
3946 Philobia enotata Gn. O.
3986 Cymatophora bitactata Wlk. O.
4140 Cleora pampinaria Gn. O.
4275*a* Metanema simpliciaria Grt. O.

4290 Stenaspilates albidula Hulst. O.
4292 Azelina ancetaria Hbn. O.
4299 Caberodes confusaria Hbn. O.

Family PYROMORPHIDÆ.

4461 Triproeris constans Hy. Edw. O.
4462 smithsonianus Clem. S.

Family SESIIDÆ.

4507 Melittia gloriosa Hy. Edw. S.
4514 Alcothoe korites Druce. O.
4545 Sesia giliæ Hy. Edw. O.
4547 mimuli Hy. Edw. O.

Family PYRALIDÆ.

4709 Nomophila noctuella Schiff. S.
4716 Loxostege obliteralis Wlk. S.
4718 helvialis Wlk. S.
4721 similalis Gn. S.
4722 allectalis Grt. S.
4725 sticticalis Linn. S.
4726 commixtalis Wlk. S. and O.
4741 ophionalis Wlk. S.
4818 Pyrausta toralis Grt. S.
4849 Noctuelia thalialis Wlk. S.
4872 Elophila avernalis Grt. O.
Thaumatopsis fernaldella Kearfott. S.
5021 Cacozelia basiochrealis Grt. S.

Family TORTRICIDÆ.

5493 Eucosoma ridingsana Rob.

SUMMARY OF FAMILIES AND SPECIES OF LEPIDOPTERA.

Nymphalidæ	22	Nolidæ	1
Libytheidæ	1	Arctiidæ	8
Erycinidæ	3	Agaristidæ	1
Lycænidæ	15	Noctuidæ	80
Papilionidæ	9	Lasiocampidæ	1
Hesperidæ	18	Geometridæ	11
Sphingidæ	6	Pyromorphidæ	2
Saturniidæ	2	Sesiidæ	4
Syntomidæ	3	Pyralidæ	13
Lithosiidæ	1	Tortricidæ	1

Species still in the hands of Messrs. Smith and Kearfott for determination, 60.

Totals: Families, 20; species, 262.

II.—LIST OF COLEOPTERA.

For the identification of species not readily determinable from the University of Kansas collection, the author is under obligations to Mr. Chas. Liebeck, Mr. H. C. Fall, and Mr. C. Schaeffer.

The numbers are those of Henshaw's list.

Abbreviations: S. for San Bernardino ranch; O. for Oak Creek canyon.

Family CICINDELIDÆ.

12 Tetracha carolina Linn. S. and O.
16*a* Cicindela obsoleta Say. S.
16*a* var. santaclaræ Bates. S.
20 nigrocærulea Lec. S.
21 pulchra Say. S.
22 hornii Schaupr. S.
23 pimeriana Lec. S.
33*a* var. maricopa Leng. O.
39 tenuisignata Fab. S.
57 lemniscata Lec. S.
arizonensis Bates. S.
wickhami W. Horn. S.
63 hæmorrhagica Lec. S.
64*b* 16-punctata Kl. S.

Family CARABIDÆ.

Cychrus vandykei Roetschke. O.
119 Carabus tædatus Fab. O.
126 Calosoma protractum Lec. S.
132 prominens Lec. S.
133 peregrinator Guer. S.
136 triste Lec. S.
140 simplex Lec. O.
215*a* Pasimachus costifer Lec. S.
218 punctulatus Hald. S.
273 Clivina ferrea Lec. S.
279 bipustulata Fab. S.
294 Panagæus sallei Chd. S.
343 Bembidium transversale Dej. S. and O.
345 lugubre Lec. S. and O.
351 lucidum Lec. O.
356 mixtum Zimm. S.
366 cordatum Lec. S.
397 dejectum Casey. S.
413 cautum Lec. O.
subangustatum Hayw. O.
timidum Lec. S.
constricticolle Hayw. S.
415 bifasciatum Mots. (=mundum Lec.) O.

449 Tachys nanus Gyll. O.
563 Pterostichus texanus Lec. S.
564 sayi Brulle. S.
579 lustrans Lec. O.
666 Amara confusa Lec. S.
674 obesa Say. O.
713 Dicælus lævipennis Lec. S.
742 Calathus gregarius Say. O.
744 opaculus Lec. O.
751 dubius Lec. O.
756 Platynus dissectus Lec. O.
771 brunneomarginatus Mann. O.
771 var. bicoloratus Germ. S.
new species. O.
773 decorus Say. S.
774*b* texanus Lec. S.
815 placidus Say. S.
842 Lachnophorus elegantulus Mann. S.
847 Casnonia pennsylvanica Linn. S.
860 Thalpius hornii Chd. S.
861 dorsalis Brulle. S.
875 Lebia majuscula Chd. S.
876 atriceps Lec. S.
882 viridis Say. S. and O.
891 scapula Horn. S.
897 furcata Lec. O.
902 bivittata Fab. S.
histrionica Bates. S.
917 Tecnophilus croceicollis Men. S.
927 Philophuga amœna Lec. S.
931 Plochionus timidus Hald. S.
940 Cymindus cribricollis Dej. S.
941 planipennis Lec. O.
985 Brachynus tschernikhii Mann. O.
986 carinulatus Mots. O.
undet. species. O.
991 Chlænius ruficauda Chd. S.
997 chaudoiri Horn. S.
1006 cumatilis Lec. S.
1008 leucoscelis Chev. S. and O.
1010 obsoletus Lec. S. and O
1022 texanus Horn. S.
1054 Nothopus zabroides Lec. S.
1055 Polpochila capitata Chd. S.
1056 Cratacanthus dubius Beauv. S.
1059 Agonoderus lineola Fab. S.
1064 indistinctus Dej. S.
1068 Discoderus impotens Lec. S.
1070 robustus Horn. S.
1081 Harpalus amputatus Say. S.

1087 Harpalus pennsylvanicus De G. S. and O.
1099 ellipsis Lec. O.
1109 fraternus Lec. O.
1121 alienus Lec. O.
1124 Selenophorus palliatus Fab. S.
1125 pedicularius Dej. S.
1158 Bradycellus rupestris Say. S.
1199 Anisodactylus maculicornis Chd. S.
1214 Pseudomorpha angustata Horn. S.

Family HALIPLIDÆ.

1229 Cnemidotus simplex Lec. S.

Family DYTISCIDÆ.

1243 Laccophilus decipiens Lec. S.
1246 pictus Lap. S.
1251 mexicanus Aube. S.
1266 Bidessus cinctellus Lec. O.
1291 Cœlambus patruelis Lec. ? O.
1294 medialis Lec. S.
1413 Agabus lugens Lec. S.
1459 Rhantus binotatus Harr. O.
1461 atricolor Aube. S.
1476 Eretes sticticus Linn. S.
1495*a* Thermonectes nigrofasciatus Aube. S.
1503 Cybister ellipticus Lec. S.

Family GYRINIDÆ.

1515 Gyrinus plicifer Lec. O.
1533 Dineutes sublineatus Chev. S.

Family HYDROPHILIDÆ.

1586 Hydrophilus triangularis Say. S.
1589 Tropisternus dorsalis Brulle. S.
1591 glaber Hbst. S.
1594 ellipticus Lec. S.
1605 Berosus styliferus Horn. S.
1607 subsignatus Lec. S.
1626 Philhydrus nebulosus Say. S.
9316 Cymbiodyta fraterculus Sharp. O.
1657 Creniphilus subcupreus Say. S.

Family SILPHIDÆ.

1698 Necrophorus marginatus Fab. S. and O.
1700 guttata Mots. S. and O.
1705 Silpha truncata Say. S. and O.

Family PSELAPHIDÆ.

Tyrus corticinus.
1917 Bryaxis foveata Lec. S. and O.
undet. species. O.

Family STAPHYLINIDÆ.

Lomechusa caseyi Wasm. S.
2059 Aleochara nitida Grav. S.
Gyrophæna?, undet. species. O.
2119 Creophilus villosus Grav. S. and O.
2123 Staphylinus nigrellus Horn. O.
2127 luteipes Lec. S.
2150 Philonthus furvus Nord. O.
2164 semiruber Horn. O.
2250 Actobius gratus Lec. S.
2305 Stenus renifer Lec. O.
Cryptobium, undet. species. S.
2500 tumidum Lec. S.
2542 Lathrobium lituarium Lec. S.
2610 Tachinus agilis Horn. O.
2636 Tachyporus californicus Horn. O.
2650 Conosoma castaneum Horn. O.
2712 Bledius armatus Er. S.
Trogophlœus?, undet. species. S.
2796 Deleaster concolor Lec. G.
2890 Lispinus æquipunctatus Lec.? O.

Family PHALACRIDÆ.

9874 Phalacrus conjunctus Casey. O.
3002 Olibrus pallipes Say. O.
3005 apicalis Melsh. S. and O.

Family COCCINELLIDÆ.

3037 Paranæmia similis Casey. S.
3046 Hippodamia convergens Guer. S. and O.
3049 sinuata Muls. O.
3051 parenthesis Say. O.
3064 Cycloneda sanguinea Linn. O.
3065 Olla oculata Fab. S.
3065*a* abdominalis Say. S.
Adalia humeralis Say. O.
humeralis, var. O.
3070 Harmonia cyanoptera Muls. S.
Anatis lecontei Casey.
3082 Exochomus pilatii Muls. O.
3090 Pentilla misella Lec. O.
9900 Thalassa montezumæ Muls. S.
3094 Brachyacantha dentipes Fab. O.
3101 Hyperaspis fimbriolata Melsh. S. and O.
3105 undulata Say. S.
3117 4-oculata Mots. S.
3126 Hyperaspidius trimaculatus Linn. O.
3138 Scymnus americanus Muls. O.
3146 hæmorrhous Lec. S.
3173 Epilachna corrupta Muls. S. and O.

Family ENDOMYCHIDÆ.

3183 Aphorista morosa Lec. O.

Family EROTYLIDÆ.

3240 Erotylus boisduvali Chev. O.

Family CUCUJIDÆ.

3299 Silvanus surinamensis Linn. S.
3339 Læmophlæus ferrugineus Steph. S.

Family CRYPTOPHAGIDÆ.

3359 Antherophagus ochraceus Melsh. O.

Family MYCETOPHAGIDÆ.

3409 Typhœa fumata Linn. S.

Family DERMESTIDÆ.

3418 Dermestes marmoratus Say. S. and O.
3420 caninus Germ. S.
3423 carnivorus Fab. O.
3438 vulpinus Fab. S.
3445 Anthrenus varius Fab. O.
3455 Orphilus glabratus Fab. O.
var. subnitidus Lec.

Family HISTERIDÆ.

3460 Hololepta lucida Lec. S.
3496 incertus Mars. O.
3502 servus Er. S.
3511 pollutus Lec. S.
3516 vernus Say. S.
3539 Epierus nasutus Horn. O.
3577 Saprinus, near obscurus Lec. O.
3607 vitiosus Lec. S. and O.
3608 lubricus Lec. S.
3610 fimbriatus Lec. O.
new species. S.
Plegaderus, near difficilis. O.

Family NITIDULIDÆ.

3671 Carpophilus yuccæ Cr. S.
undet. species. O.
3721 Nitidula ziczac Say. S. and O.
3737 Meligethes mutatus Har. O.
Ips, new species. S.
3763 Pityophagus verticalis Horn. O.

Family LATRIDIIDÆ.

Latridius, sp. between cordicollis and liratus. O.
3810 Melanopthalma americana Mann. O.
distinguenda Com. S. and O

Family TROGOSITIDÆ.

3833 Trogosita virescens Fab. S. and O.
3837 Tenebrioides pleuralis Horn. O.
3838 corticalis Melsh. O.
3841 sinuata Lec. S.
3848 Peltis pippingskœldi Mann. O.

Family PARNIDÆ.

Parnus arizonensis Schaeffer. S.
3920 Dryops productus Lec. S. and O.

Family ELATERIDÆ.

4064 Anelastes drurii Kirby. O.
4077 Adelocera rorulenta Lec. O.
4086 Meristhus cristatus Horn. S.
4090 Chalcolepidius smaragdinus Lec. S.
10035 behrensi Cand. S. and O.
4092 Alaus lusciosus Hope. S. and O.
4095 melanops Lec. O.
10047 Cardiophorus dispar Blanch. S.
4101 edwardsii Horn. O.
4110 longior Lec. O.
4112 fulvipes Lec. O.
arizonicus Fall. New species. O.
4128 Horistonotus simplex Lec. S.
4181 Monocrepidius lividus De G. S.
4188 sordidus Lec. S.
4197 Ischiodontus soleatus Say. S.
4202 Elater rhodopus Lec. O.
4210 cordatus Horn. O.
4306 Melanotus macer Lec. S.
4322 fissilis Say. S.
4324 exuberans Lec. O.
4394 Athous nigripilis Mots. O.
4465 Corymbites rupestris Germ. O.
4482 hieroglyphicus Say. O.
4610 Asaphes memnonius Hbst. O.
Scaptolenus, new species. S.

Family BUPRESTIDÆ.

4561 Gyascutus obliteratus Lec. S.
4564 Hippomelas sphenicus Lec. S.
4565 cælatus Lec. S.
4568 Chalcophora angulicollis Lec. O.
4604 Buprestis nuttalli Kirby. O.
4605 læviventris Lec. O.
4610 lauta Lec. O.
4634 Anthaxia flavimana Gory. O.
4636 Chrysobothris octocola Lec. S.
4637 atabalipa Lap. S.
4639*a* alabamæ Gory. S. and O.

4639*b* Chrysobothris 4-impressa Lap. & Gory. O.
4639*c* lesueuri Lap. & Gory. O.
4641 cuprascens Lec. O.
4650 trinervia Kirby. O.
4653 debilis Lec. S.
4656 gemmata Lec. S.
near bicolor Horn. O.
new species. O.
10070 axillaris Horn. O.
10084 ærea Chev. O.
10094 Actenodes mendax Horn. S.
4675 Polycesta velasco Lap. & Gory. S.
velasco, var. or a new species O.
4677 Acmæodera amplicollis Lec. S. and O.
4679 amabilis Horn. O.
4686 miliaris Horn. O.
4687 sparsa Horn. S. and O.
4690 connexa Lec. S. and O.
4698 mima Gory. S.
4699 pulchella Hbst., var. O.
10101 bivulnera Horn. S.
4705 guttifera Lec. S.
10107 delumbis Horn. S.
disjuncta Fall. S.
falli Kerremans (=subcyanea Fall.) S.
conoidea Fall. O.
new species. O.
undet. species. S.
4743 Agrilus solitarius Gemm. O.
4746 egenus Gory. C.
10131 felix Horn. O.
new species. O.
4764 Pachyscelus purpureus Say.

Family LAMPYRIDÆ.

4767 Rhyncheros sanguinipennis Say. O.
4769 Lycus fernandezii Duges. S.
4800 Lygistopterus rubripennis Lec. O.
4811 Lucidota punctata Lec. O.
4815 Ellychnia corrusca Linn. O.
4817 Propyga fenestralis Melsh. S.
4845 Microphotus dilatatus Lec. S.
4865 Chauliognathus profundus Lec. S.
4872 scutellaris Lec. S.
4876 marginatus Fab. S.
Polemius regularis Fall. S.
undet. species. O.
4976 Malthodes bicolor Lec. O.

Family MALACHIDÆ.

5002 Collops bipunctatus Say. S. and O.
5004 4-maculatus Fab. O.
4-maculatus, var. O.
5010 laticollis Horn. O.
5012 punctulatus Lec. S.
new species. S.
5051 Attalus basalis Lec. O.
5055 moralus Lec. O.
new species. S.
three undet. species.
Pristoscelis, undet. species. O.
5109 Listrus senilis Lec. S. and O.

Family CLERIDÆ.

5127 Elasmocerus terminatus Say. S.
californicus Fall. S.
5134 Cymatodera cylindricollis Chev. S. and O.
5140 hopei Gray. O.
5151 ovipennis Lec. O.
arizonæ Wolcott. New species. S.
5155 Aulicus nero Spin. S.
5157 Trichodes illustris Horn. S.
5158 ornatus Say. O.
5164 Clerus spinolæ Lec. S.
5165 quadrisignatus Say. S.
5173 abruptus Lec. S.
5177 nigriventris Lec. O.
5179 mœstus Kl.
snowi Wolcott. New species. O.
5191 Hydnocera subfasciata Lec. O.
5197 discoidea Lec. S. and O.
new species. O.
5207 longa Lec. S.
5223 Enoplium humerale Horn. O.
5230 Necrobia rufipes Fab. S. and O.

Family PTINIDÆ.

Catorama gibbulum Fall. S.
inæquale Fall. S.
5340 Sinoxylon sericans Lec. S.
5343 sextuberculatum Lec. S.
5354 Amphicerus fortis Lec. S.
5377 Trogoxylon californicum Cr. S.

Family CIIDÆ.

Cis, three undet. species. O.

Family SCARABÆIDÆ.

5430 Canthon puncticollis Lec. S.
5432*a* corvinus Horn. S.
5433 cyanellus Lec. S.

5435 Canthon lævis Drury. S.
5437 indigaceus Lec. S.
5452 Phanæus carnifex Linn. S.
5457 Onthophagus coproides Horn. O.
10186 Atænius læviventris Horn. O.
5497 hirtus Horn. O.
5521 Aphodius crassulus Horn. O.
5529 vittatus Say. S.
5579 Ochodæus simplex Lec. S.
5582 frontalis Lec. S.
5583 striatus Lec. S.
5589 Bradycinetus serratus Lec. S.
5612 Trox scutellaris Say. S.
5617 punctatus Germ. S.
5618 tuberculatus De G. O.
5620 sonoræ Lec. O.
5648 Hoplia laticollis Lec. O.
5665 Dichelonycha truncata Lec. O.
5684 Serica mixta Lec. O.
5700 Diplotaxis puberula Lec. S.
undet. species near tristis Kirby. S.
undet. species near angularis Lec. S.
5718 dubia Lec.? S.
10262 Lachnosterna fucata Horn. S.
10264 ignava Horn. O.
5801 Phytalus cephalicus Horn. O.
5809 Listrochelus scoparius Lec. O.
5813 obtusus Lec.? O.
5820 Polyphylla hammondi, var. subvittata Lec. S.
5822 decemlineata Say. O.
5832 Anomala centralis Lec. S.
5846 Pelidnota lugubris Lec. S.
5848 Plusiotis lecontei Horn. O.
5865 Cyclocephala dimidiata Burm. S. and O.
5866 manca Lec. O.
5867 Chalepus obsoletus Lec. S.
5869 Ligyrus gibbosus De G. S.
10276 Aphonides dunniana Rivers. S.
5878 Orizabus snowi Horn. O.
5879 ligyroides Horn. O.
5880 Xyloryctes satyrus Fab. O.
5891 Phileurus illatus Lec. S.
5893 Allorhina mutabilis Gory. S.
Gymnetis impius Fall. S.
5903 Euphoria devulsa Horn. S.
5908 fascifera Lec. S.
5911 inda Linn. O.
5913 Cremastochilus planatus Lec. S.
5914 saucius Lec. S.

Family SPONDYLIDÆ.

5946 Parandra brunnea Fab. O.

Family CERAMBYCIDÆ.

5960 Ergates spiculatus Lec. O.
Derobrachus ferreri Casey. S.
5961 Prionus californicus Mots. O.
5964 palpalis Say. O.
5973 Nothorhina aspera Lec. O.
5974 Criocephalus productus Lec. O.
5976 asperatus Lec. O.
5990 Hylotrupes bajulus Linn. O.
6055 Elaphidion alienum Lec. S.
6067 Aneflus tenuis Lec. S.
6076 protensus Lec. S.
6105 Rhopalophora longipes Say. S. and O.
6115 Callichroma plicatum Lec. S.
6122 Stenaspis solitaria Say. S.
6126 Tragidion annulatum Lec. O.
6127*a* fulvipenne Say. O.
6147 Tylosis maculata Lec. S.
6153 Crossidius pulchellus Lec. S.
10298 longipennis Casey. S.
6158 Sphænothecus suturalis Lec. S.
6164 Stenosphenus lepidus Horn. S.
6166 debilis Horn. O.
new species. O.
6168 Cyllene antennatus White. S.
6172 decorus Oliv. O.
6180 Xylotrechus sagittatus Germ. O.
6332*b* Leptura cribripennis Lec. O.
10319 Ophistomis ventralis Horn. O.
6370 Monilema appressum Lec. S. and O.
6410 Cœnopœus palmeri Lec. S.
Liopus, undet. species. O.
6433 Deetes spinosus Say. S.
Hyperplatys, undet. species. O.
6447 Acanthocinus spectabilis Lec. O.
6455 Pogonocherus volitans Lec.? O.
6468 Oncideres texana Horn. S.
tessellatus Thoms. S.
6490 Mecas inornata Say. O.
6513*c* Tetraopes oregonensis Lec. O.

Family CHRYSOMELIDÆ.

10331 Aulacoscelis purpurea Horn. O.
6573 Lema trilineata Oliv. S.
6574 nigrovittata Guer. S.
undet. species. O.
undet. species near collaris Say. O.
6580 Anomœa mutabilis Lac. S.

6582 Euryscopa lecontei Cr. S.
parvula Jac. S.
6588 Coscinoptera canella Lec. S.
6589 mucorea Lec. S.
6593 Megalostomis pyropyga Lac. S.
6596*b* Babia tetraspilota Lec. S. and O.
6597 Saxinis apicalis Lec. S.
6598 omogera Lac. O.
6599 saucia Lec. O.
10346 sonorensis Jac. O.
6600 Urodera crucifera Lac. O.
6614 Cryptocephalus 4-maculatus Say. O.
6622 leucomelas Suffr. O.
6627 spurcus Lec. S.
new species. O.
6665 Pachybrachys viduatus Fab. S.
undet. species near atomarius Melsh. O.
convexus Jac.? O.
two new species. O.
two new species. S.
6707 Diachus auratus Fab. O.
6721 Xanthonia villosula Melsh. O.
6740 Myochrous squamosus Lec. S.
6741 Chrysochus auratus Fab. O.
6747*b* Paria 4-notata Say. S.
Metachroma, undet. species near californicum Cr. S.
6767 Graphops pubescens Melsh. S. and O.
Nodonota, undet. species. S.
6772 Chrysodina globosa Say. O.
6774 Colaspis brunnea Fab., var. S.
10366 intermedia Jac. S.
championi Jac. S.
6787 Doryphora lineolata Stal. S.
6789 10-lineata Say. S.
6792 haldemani Rog. S.
10373 peninsularis Horn. S.
6795 Chrysomela exclamationis Fab. S.
6796 conjuncta Rog. O.
6800 var. heterothecæ Linell. O.
6813 tortuosa Rog. S.
6815 serpentina Rog. S.
6821*a* cribraria Rog. O.
6836 Lina arizonæ Cr. S.
10382 Phyllecthrus subsulcatus Horn. S.
6881*a* Diabrotica tenella Lec. S. and O.
6883 balteata Lec. S.
6885 vittata Fab. S.
6887 virgifera Lec. S.
10401 Halticidea placida Horn. O.
6904 Galeruca tuberculata Say. O.
6911 integra Lec. O.

6916 Monoxia guttulata Lec. S.
6918 sordida Lec. S.
6933 Œdionychis lugens Lec. O.
6949 Disonycha 5-vittata Say. O.
6953 arizonæ Casey. S.
10419 politula Horn. S.
6960 Haltica bimarginata Say. O.
6962 carinata Germ. S. and O.
6971 foliacea Lec. S.
6980 Crepidodera helxines Linn. S.
6991 parvula Fab. O.
7002 Systena marginalis Ill. S.
7003 tæniata Say, var. blanda Melsh. S.
7010 Longitarsus livens Lec.? S.
7027 Phyllotreta albionica Lec. S.
7028 lewisii Cr. O.
7058 Psylliodes punctulata Melsh. S.
7064 Microrhopala vulnerata Horn. O.
7068 cyanea Say. O.
7073 Odontota collaris Say. O.
7087 Charistena bicolor Smith. S.
7098 Cassida bivittata Say. S.
Coptocycla, near aurichalcea Fab. O.
7103 arizonæ Cr. S.
7106 lecontei Cr. S.
7107 clavata Fab. S.
7109 Chelymorpha argus Licht. S.

Family BRUCHIDÆ.

7129 Bruchus cruentatus Horn. S.
7133 pruininus Horn. S.
7137 prosopis Lec. S.
7156 placidus Horn. O.
10474 julianus Horn.
new species. S.

Family TENEBRIONIDÆ.

7177 Trimytis pruinosa Lec. S.
7183 Eurymetopon emarginatum Casey. S.
10485 cylindricum Casey. S.
7196 Emmenastus acutus Horn. O.
7200 Epitragus submetallicus Lec. S.
7203 canaliculatus Say. S.
7203 pruinosus Horn. S.
10507 fusiformis Casey. S.
7221 Zopherus gracilis Horn. O.
7251 Ologlyptus anastomosis Say. S.
7261 Asida morbillosa Lec. S.
7283 convexicollis Lec. S.
7284*a* rimata Lec. S.
7286 elata Lec. S.
blapsoides Sol. O.

7307 Eusattus reticulatus Say. S.
7322 Eleodes carbonaria Say. O.
7324 quadricollis Esch. O.
7325 humeralis Lec. O.
7331 longicollis Lec. O.
7335 gracilis Lec. S.
7339 nigrina Lec. O.
7350 lecontei Horn. O.
7351 consobrina Lec. O.
7353 planipennis Lec. O.
10547 rileyi Casey. O.
10550 porcatus Casey. O.
7365 Embaphion contusum Lec. O.
7379 Argoporis costipennis Lec. O.
10568 alutacea Casey. S.
7392 Nyctobates subnitens Horn. S.
7394 Iphthimus serratus Mann. O.
7394*a* sublævis Bland. O.
Alæphus gracilis Fall. New species. O.
7422 Adelina lecontei Horn. S.
10577 Mecysmus parvulus Casey. S.
7432 Blapstinus auripilis Horn. S.
7433 dilatatus Lec. S.
7437 lecontei Muls. S.
7452 Notibius gagates Horn. S.
10617 Tribolium confusum Duv. S.
7489 Anædus rotundicollis Lec. S.
7520 Platydema americanum Lap. O.
7530 Hypophlœus substriatus Lec. O.
7568 Helops arizonensis Horn. S.
new species. S.

Family CISTELIDÆ.

10638 Lystronichus piliferus Champ. S.
10647 Hymenorus grandicollis Champ. S.
10653 prolixus Casey. O.
10659 ruficollis Champ. S.
near occidentalis Champ.
10678 Telesicles cordatus Champ. S.

Family LAGRIIDÆ.

10702 Statira pluripunctata Horn. S.

Family MONOMMIDÆ.

7645 Hyporhagus gilensis Horn. S.

Family MELANDRYIDÆ.

10709 Eustrophus repandus Horn. O.

Family ŒDEMENIDÆ.

7730 Ditylus obscurus Lec. S.
7746 Oxacis bicolor Lec. S.
7747 fuliginosa Lec. S.
lucana Lec. S.
subfusca Horn. S.

Family MORDELLIDÆ.

7760 Diclidia lætula Lec., var. O.
7761 Pentaria trifasciata Melsh. O.
7771 Anaspis pusio Lec. O.
7780 Mordella scutellaris Fab. S. and O.
Glipodes, undet. species. O.
Mordellistena, undet. species near adspersa Melsh. O.
probably new species. S.

Family ANTHICIDÆ.

Macratria brunnea Casey. S.
7919 Notoxus bifasciatus Lec. S. and O.
curvitrichus Casey.
7943 Anthicus californicus Laf. S.
7945 floralis Linn. S.
7965 obscurellus Lec. S.
7975 corcinus Lec. S.

Family MELOIDÆ.

8025 Nemognatha apicalis Lec. O.
8027 bicolor Lec. S.
8033 nigripennis Lec. O.
new species near immaculata Say. S.
8037 immaculata Say. S.
8042 Gnathium francilloni Kirby. O.
8047 Zonitis atripennis Say. S.
8049 bilineata Say. S.
three new species. S.
8056 Macrobasis longicollis Lec. S.
8067 tenella Lec. S.
8069 segmentata Say. S.
undet. species. O.
8074 Pleuropompha costata Lec. S.
8082 Epicauta ferruginea Say. S.
8085 callosa Lec. S.
8091 pardalis Lec. S.
8092 maculata Say. S.
8098 cupreola Duges. S.
8103 corvina Lec. S.
alastor Skinner. S.
abadona Skinner. S.
new species. S.
8107 Pyrota mylabrina Chev. S.
8110 postica Lec. S.
8130 Cantharis deserticola Horn. S.
8138 puberula Lec. O.
8139 biguttata Lec. S.

Family RHIPIPHORIDÆ.

8172 Toposcopus wrightii Lec. O.
8174 Rhipiphorus dimidiatus Fab. O.
8177 pectinatus Fall. S.

Family OTIORHYNCHIDÆ.

8249 Eupagoderes sordidus Lec. S.
8258 Anametis grisea Horn. O.
8267 Peritaxia hispida Horn. S.
8299 Aragnomus griseus Horn. O.
Pandeletejus, undet. species. O.
8317 Cyphus lautus Lec. S. and O.
lautus var. S.
8338 Coleocerus marmoratus Horn. S.

Family CURCULIONIDÆ.

8379 Apion melanarium Gerst. S. and O.
occidentale. S.
10860 Dinocleus denticollis Casey. O.
8515 Cleonaspis pulvereus Lec. S.
Cleonus, undet. species. S.
8546 Desmoris constrictus Say. S. and O.
8558 Smicronyx fulvus Lec. O.
undet. species. O.
8571 Endalus limatulus Gyll. S.
8603 Otidocephalus vittatus Horn. S.
8606 scrobicollis Boh. O.
8672 Orchestes puberulus Boh. O.
Tychius, undet. species near setosus Lec. O.
8711 Læmosaccus plagiatus Fab. O.
8716 Conotrachelus seniculus Lec. S.
8741 Rhyssematus palmacollis Say. S.
8742 lineaticollis Say. S.
8745 pruinosus Boh. S.
8812 Copturus nanulus Lec. S. and O.
8835 Cœliodes acephalus Say. O.
Pelenomus, undet. species. O.
8886 Pseudobaris farcta Lec. O.
Onychobaris, undet. species. O.
11160 Centrinus hospes Casey. S.
11178 Centrinites strigicollis Casey. O.

Family CALANDRIDÆ.

11214 Cactophagus subnitens Casey (according to Mr. Schæffer; gravidus Lec., says Mr. Fall). S.
8973 Scyphophorus acupunctatus Gyll.
8980 Sphenophorus simplex Lec. S.
three undet. species. S.
9026 Cossonus concinnatus Boh. O.
11237 Rhyncolus nimius Casey. O.

Family SCOLYTIDÆ.

9060 Pityophthorus materiarius Fitch.? O.
9064 pilosulus Lec.? O.
9146 Scolytus unispinosus Lec. O.
9162 Hylesinus imperialis Lec. O.

9179 Dendroctonus terebrans Oliv. O.
9190 Hylastes longus Lec. O.
9191 rufipennis Kirby. O.
. undet. species. O.

SUMMARY OF FAMILIES AND SPECIES OF COLEOPTERA.

Cicindelidæ	14	Lampyridæ	13
Carabidæ	81	Malachidæ	14
Haliplidæ	1	Cleridæ	21
Dytiscidæ	12	Ptinidæ	6
Gyrinidæ	2	Ciidæ	3
Hydrophilidæ	9	Scarabæidæ	52
Silphidæ	3	Spondylidæ	1
Pselaphidæ	3	Cerambycididæ	39
Staphylinidæ	20	Chrysomelidæ	86
Phalacridæ	3	Bruchidæ	6
Coccinellidæ	22	Tenebrionidæ	46
Endomychidæ	1	Cistelidæ	6
Erotylidæ	1	Lagriidæ	1
Cucujidæ	2	Monommidæ	1
Cryptophagipæ	1	Melandryidæ	1
Mycetophagidæ	1	Œdemeridæ	5
Dermestidæ	7	Mordellidæ	7
Histeridæ	12	Anthicidæ	7
Nitidulidæ	6	Meloidæ	30
Latridiidæ	3	Rhipiphoridæ	3
Trogositidæ	5	Otiorhynchidæ	8
Parnidæ	2	Curculionidæ	25
Elateridæ	26	Calandridæ	8
Buprestidæ	44	Scolytidæ	8

Species in the hands of Mr. C. Schaeffer for determination, 46.
Totals: Families, 48; species, 724.

III.—LIST OF HEMIPTERA-HETEROPTERA.

This list includes all Arizona species collected by the University of Kansas entomological expeditions of 1902, 1903, 1904, and 1905.

The author is indebted to Messrs. E. P. Van Duzee and Otto Heidemann for the determination of species not readily identified from the University collections.

The numbers are those of Uhler's check-list.

Abbreviations: S. for San Bernardino ranch, eighteen miles east of Douglas, in Cochise county, altitude 3750 feet; O. for Oak Creek canyon, eighteen miles southwest of Flagstaff, altitude 6000 feet; B. for Bill Williams fork of the Colorado river, on the boundary line between Mohave and Yuma counties, altitude 1000 feet;

H. for Humphrey's Peak, fifteen miles north of Flagstaff, altitude 9500 feet; M. for Martinez, or Congress Junction, in Yavapai county.

Family SCUTELLERIDÆ.

25 Homæmus æneifrons Say. S.
26 proteus Stal. S.
bijugis Uhl. S.

Family CORIMELÆNIDÆ.

54 Corimelæna cærulescens Stal. S.
58 extensa Uhl. O.
64 nigra Dallas. S.
renormata Uhl. S.

Family CYDNIDÆ.

75 Cyrtomenus mirabilis Perty. O. and S.
Geotomus parvulus Sign. S.

Family PENTATOMIDÆ.

145 Perillus bioculatus Fab. S.
bioculatus, var. claudus Say. O.
148 Zicrona cuprea Dallas. S.
168 Podisus crocatus Uhl. S.
174 acutissimus Stal. S.
Liopus contaminatus Uhl. M.
Brochymena, undet. species near 4-pustulata Fab. S.
190 quadripustulata Fab. S.
192 obscura H. Schf. M. and S.
Pelidnocoris, undet. species. S.
216 Mecidea longula Stal. S.
Cosmopepla uhleri Montel. O.
223 carnifex Fab. O. and H.
242 Mormidea tetra Walk. S.
247 Euschistus servus Say. S. and O.
255 spurculus Stal. S.
257 biformis Stal. S.
258 integer Stal. S.
277 Menecles insertus Say. O.
282 Pentatoma ligata Stal. S.
osborni Van D. S.
284 sayi Stal. S. and B.
faceta Say. S.
296 Peribalus limbolarius Stal. S.
298 abbreviatus Uhl. S. and O.
300 Thyanta custator Fab. S., B., and M.
303 rugulosa Say. S.
brevis Van D.
Chlorocoris, undet. species near complanatus Guer. S.
314 Murgantia histrionica Hahn. S. and O.
336 Nezara hilaris Say. O.
344 Banasa sordida Uhl. O.

Family COREIDÆ.

438 Corynocoris distinctus Dallas. S.
440 Pachylis gigas Burm. S.
446 Mozena lineolata H. Schf. S., M., and B.
461 Archimerus calcarator Fab. O.
482 Acanthocephala granulosa Dallas. S.
493 Leptoglossus zonatus Dallas. S.
two undet. species. S.
494 near stigma Hrbt. S.
500 Narnia femorata Stal.? S.
501 pallidicornis Stal. M.
507 Chelinidea vittigera Uhl. S. and B.
515 Catorhintha mendica Stal. S.
517 selector Stal. S. and B.
522 Anasa tristis De G. S.
564 Alydus eurinus Say. S. and O.
566 (Megalotomus) quinquespinosus Say. O.
569 pluto Uhl. S. and O.
571 Stachyocnemus apicalis Dallas. S.
579 Scolopocerus secundarius Uhl. S.
580 uhleri Dist. S.
587 Harmostes reflexulus Stal. S. and O.
587 form virescens Dallas. S.
588 fraterculus Say. S. and O.
594 Aufeius impressicollis Stal. S.
595 Corizus hyalinus Fab. B.
599 bohemani Sign. O.
601 lateralis Say. S.
606 Leptocoris trivittatus Say. O.

Family BERYTIDÆ.

582 Jalysus spinosus Say. S. and B.
583 Acantholæna annulata Uhl. B.

Family LYGÆIDÆ.

Nysius minutus Uhl. S., O., and H.
near angustatus Uhl. S.
618 californicus Stal. S., O., B., H., and H. at summit, alt. 12,800 ft.
639 Geocoris pallens Stal. O. and S.
undet. species. S.
Heræus eximius Dist.
649 Phlegyas annulicrus Stal. S.
678 Ozophora picturata Uhl. O.
Scolopostethus thomsoni Reut. O.
Ptochiomera, new species. O.
Rhyparochromus floralis Uhl. S.
713 Lygæus bicrucis Say. S. and O.
715 facetus Say. S.
716 circumlitus Stal. O.
743 bicolor H. Schf. O. and B.
746 trux Stal. S.

752 Lygæus reclivatus Say. S. and O.
753 turcicus Fab. M. and B.
melanopleurus Uhl. O.
melanopleurus, var. brachypterus. O.
759 Oncopeltus fasciatus Dallas. S. and B.

Family LARGIDÆ.

765 Largus cinctus H. Schf. O.
766 succinctus Linn. S., O., and B.
773 Arhaphe carolina H. Schf. O.
779 Dysdercus obliquus H. Schf. S.

Family CAPSIDÆ.

806 Clivinema villosa Reut. S.
834 Resthenia persignanda Dist. S.
undet. species. O.
Phytocoris, new species near ramosus. S.
856 Compsocerocoris annulicornis Reut. S.
860 Calocoris rapidus Say. O.
863 superbus Uhl. S.
Lygus, new species. S.
881 pratensis Linn. S. and O.
pratensis, var. S.
889 invitus Say. S.
902 Pœciloscytus basalis Reut. S. and B.
Lampethusa anatina Dist. S.
920 Camptobrochis nebulosus Uhl. O.
644 Pycnoderes insignis Reut. S.
Halticoma, new species. S.
valida Uhl., MS. O.
Coquillettia mimetica Osborn. S.
insignis Uhl. O.
Oncotylus guttulatus Uhl. S.
989 Macrocoleus coagulatus Uhl. S. and H.
Psallus, undet. species. O.
997 Plagiognathus obscurus Uhl. O.
998 Atomoscelis seriatus Reut., var. S.

Family ARADIDÆ.

1077 Aradus similis Say.? O.
1105 Brachyrhynchus emarginatus Say.? O.

Family PHYMATIDÆ.

1118 Phymata erosa Linn. S. and O.

Family NABIDÆ.

1133 Pagasa nitida Stal. B.
1114 Coriscus ferus Linn. S. and O.
undet. species. S.

Family REDUVIIDÆ.

Sinea complexa Caudell. S. and B.
1152 diadema Fab. S., O., and B.
rileyi Montel. M.
1155 raptoria Stal. S.
1156 defecta Stal. O.
1159 Acholla multispinosa De G. O.
1172 Atrachelus cinereus Fab. S. and B.
1180 Castolus subinermis Stal. O.
1187 Milyas zebra Stal. O. and H.
1193 Zelus cervicalis Stal. S.
exsanguis Stal. B.
pictipes Dist. S.
1209 Pindus socius Uhl. S., M., and B.
1212 Apiomerus subpiceus Stal.? S.
1214 crassipes Fab. O.
spissipes Say. S.
Homalocorus minutus Mayr.? O. and H.
1232 Rasahus thoracicus Stal. S.
1237 Melanolestes abdominalis H. Schf. S.
1248 Conorhinus variegatus Drury. S.
1259 Opsicœtus personatus Linn. O.
1269 Pygolampis pectoralis Say. S.
Oncocephalus, new species. S.
1274 Narvesus carolinensis Stal. S.

Family LIMNOBATIDÆ.

1300 Hydrometra martini Kirkaldy. B.

Family GERRIDÆ.

1302 Gerris remigis Say. S., H., and O.

Family VELIIDÆ.

Velia brachialis Stal. O. and B.
Rhagovelia, undet. species. B. and H.

Family SALDIDÆ.

1337 Salda polita Uhl. B.

Family GELASTOCORIDÆ.

1356 Pelogonus americatus Uhl. B.
1357 Gelastocoris oculatus Fab. B., O., and H.

Family NAUCORIDÆ.

1362 Ambrysus signoretii Stal. S.
1365 melanopterus Stal. B.

Family BELOSTOMATIDÆ.

1372 Belostoma fusciventris Stal. S.
1373 anurus H. Schf. B. and O.

FAMILY NEPIDÆ.

1396 Ranatra quadridentata Stal.

Family NOTONECTIDÆ.

1398 Notonecta insulata Kirby. S.
1401 mexicana Am. & S. S.
indica Linn. S.

Family CORIXIDÆ.

Corixa, undet. species. B.
two undet. species. S.
Buenoa platycnemis Fieb. S.
Dendrocoris, apparently a new species. S.

SUMMARY OF FAMILIES AND SPECIES OF HEMIPTERA-HETEROPTERA.

Scutelleridæ	3	Reduviidæ	24
Corimelænidæ	4	Limnobatidæ	1
Cynidæ	2	Gerridæ	1
Pentatomidæ	32	Veliidæ	2
Coreidæ	29	Saldidæ	1
Berytidæ	2	Gelastocoridæ	2
Lygæidæ	21	Naucoridæ	2
Largidæ	4	Belostomatidæ	2
Capsidæ	24	Nepidæ	1
Aradidæ	2	Notonectidæ	3
Phymatidæ	1	Corixidæ	5
Nabidæ	3		

Totals: Families, 23; species, 171.

The author will publish at a later date lists of species belonging to the other orders of insects, together with additions to the foregoing lists from material not yet determined.

V.

BOTANICAL PAPERS.

"THE BOTANICAL FEATURES OF THE NEW UNITED STATES PHARMACOPŒIA."

By L. E. SAYRE, University of Kansas, Lawrence.

"A LITTLE EXPERIMENT IN FLOWER-MAKING."

By GRACE MEEKER, Ottawa.

"NOTES ON THE FLORA OF THE ROSEBUD INDIAN RESERVATION, SOUTH DAKOTA."

By ALBERT B. REAGAN.

THE BOTANICAL FEATURES OF THE NEW UNITED STATES PHARMACOPŒIA.

By L. E. SAYRE, University of Kansas, Lawrence.

THE eighth decennial revision of the United States Pharmacopœia, which has recently been published, is of interest to the chemist and botanist alike. In the pages of this legal standard there is contained a list of drugs derived from the vegetable kingdom. These drugs are from various parts of plants and the plants are distributed very widely over the globe. It is exceedingly interesting to the botanist to note that in the references made to botanical drugs an effort has been made in the recent revision, as far as possible, to restore the names given to the plants by the original authors. In some cases it has been almost impossible to make any such changes; for example, in our common wild cherry, which was made official in this standard work scores of years ago, and under the name of *Prunus virginiana*. It is well known that the botanical source of the medicinal wild cherry bark is from *Prunus serotina*. Therefore, the United States Pharmacopœia speaks of wild cherry as *Prunus virginiana* derived from the bark of *Prunus serotina*. Quite a number of changes have occurred in the new pharmacopœia resulting from the changes which investigation has made necessary in transferring plants into new families or natural orders. No less than twelve changes have been made by transferring plants into other orders than were formerly recognized as the proper order. In the case of Urticacæ, for example, in the pharmacopœia of 1890 the natural order Urticacæ included the following drugs: *Ulmus*, *Humulus*, *Cannabis indica*, *Ficus*. In the present pharmacopœia *Ulmus* is placed under the new order Ulmaceæ, and *Humulus* and *Cannabis indica* under the Moracacæ. Many of the plants and products of the pines that were formerly classified under the natural order Coniferæ are now classified under the family Pinaceæ. Examples of such changes as these, as I have said, are of interest to the botanist, and it goes to show that as old a science as botany claims to be, it is by no means incapable of change and improvement, when such changes as these are possible.

Under the description of drugs derived from the vegetable kingdom, the pharmacopœia shows strikingly the progress which has

been made in microscopical botany. Descriptions of crude drugs requiring the use of the compound microscope are found repeatedly in the text. Scattered here and there in the text of the pharmacopœia are found such statements as the following, quoting a paragraph under *Althæa* (marshmallow): "The powder contains rosette-shaped crystals of calcium oxalate, about 0.025 mm. in diameter, and ellipsoidal starch grains from 0.010 to 0.020 mm. in diameter."

The measurement of the official (corn) starch is stated as from about 0.010 to 0.025 mm. in diameter, but these are usually polygonal grains. In elm bark there are noted a few nearly spherical starch grains measuring from 0.005 to 0.010 mm. in diameter. We frequently hear the statement made that lycopodium consists of the pollen of *Lycopodium clavatum.* The pharmacopœia states that these microscopical elements are tetrahedral spores, from 0.025 to 0.040 mm. in diameter, and are multicellular; and that the microscope should reveal neither pollen nor starch grains.

In the case of *Sinapis* (both black and white mustard seed) and in flaxseed, the presence of starch, while admitted, is not revealed by the microscope. In these cases a "limit test" for starch is given, which, in the case of the mustards, reads as follows: "If 1 gm. of the powder be exhausted by slow percolation with alcohol and the mass mixed with 200 c.c. of water and heated to boiling, and if, after cooling, sufficient cold water be added to make the mixture measure 1000 c.c., the addition of 4 c.c. of tenth-normal iodine t. s. should not produce a dark blue color."

In the case of flaxseed, the limit test is substantially the same, but varies from the former, as will be seen: "If 1 gm. of ground linseed be mixed with 20 c.c. of water and the mixture heated to boiling, then cooled and diluted with cold water to 100 c.c., the addition of 0.5 c.c. of iodine t. s. should not produce more than a pale blue color."

It is important to note in this connection also that the compound microscope is called into requisition in the identification of anatomical structures, as, for example, in the description of the barks derived from *Viburnum opulus* and *Viburnum prunifolium.* Under *V. opulus* it is stated that transverse sections of the bark show several bands of bast fibers; while in the case of the *prunifolium* the statement is met that the cross-sections show groups of stone cells. These elements are satisfactorily distinguishable only by the aid of a one-inch (better by a one-fifth) objective, and seem to distinguish the two barks, even in form of powder.

In the new edition of the pharmacopœia it is evident that the committee of revision have endeavored to express in as few words as possible the most essential characteristics of the drug. The descriptions of these characteristics have been compressed into an average space of about ten lines. In the case of the description of aniseed, we have the following statement: "Ovoid, laterally compressed, 4 to 5 mm. long; carpels usually cohering and attached to a slender pedicel; grayish to greenish gray to grayish brown; each with a flat face and five light brown filiform ridges and about sixteen oil-tubes; odor and taste agreeable and aromatic. No mouse-like odor should be developed when solution of potassium hydroxide is poured upon anise (absence of conium). The powder contains one-celled, straight or curved, non-secreting hairs, which vary from 0.025 to 0.100 mm. in length."

Those who are familiar with these substances know how important it is to distinguish anise from conium, a poisonous fruit from the same family; a fruit which is readily mistaken for the innocent, aromatic aniseed. It would be impossible in this paper to give anything like a satisfactory analysis of the botanical work of the present pharmacopœia. The detailed description of the changes and improvements would require a small volume, but it is the object of this paper to call attention not only to the pharmacopœia itself, but to the botanical features of it which botanists should be interested in. Indeed, all scientists who are interested in the progress of a national work, a work that is recognized by various state laws and by the United States government, should be interested in the reviewing of this recently revised standard for medicinal substances, whether from the point of view of the sciences connected with the vegetable, animal or mineral kingdom.

A LITTLE EXPERIMENT IN FLOWER-MAKING.

By Grace Meeker, Ottawa.

THE little experiment in new flower-making which it is my pleasure to present to you was undertaken by Mrs. Orpha Kious Davis. In the spring of 1901, she sent to Winnipeg, Manitoba, for a chrysanthemum that bloomed early enough to escape the frosts of that northern climate. I cannot give the name of the variety which has this merit, but it is certainly a yellow-flowering one.

Having obtained the chrysanthemum, she planted with it plants of the common wild sunflower, in the hope of obtaining a cross between the two. Her method of effecting the exchange of pollen was simple—she brushed the faces of the flowers together in the morning "while the dew was on." The sunflowers fruited well, as is their wont, and the second season (1902) she planted seed from those plants again with the chrysanthemums. The flowers of the sunflower showed a few ligulate corollas in the disk and were misshaped and ugly. During this season she again brushed the faces together and saved the seed for planting.

In 1903 the results were much better; the flowers were quite double; that is, many of the tubular flowers of the disk were replaced by the ligulate corollas of the chrysanthemum, but the flowers were small.

During 1904 Doctor and Mrs. Davis were at the exposition in St. Louis, and nothing was done with the new flower. However, an incident occurred of sufficient value to record. A friend of Mrs. Davis from Bucyrus, Ohio, received three seeds of the flower which Doctor Davis happened to have in his pocket. After her return home, that is, this season, she planted the seeds and got excellent results. Unfortunately her letter telling of her success has been destroyed.

This season (1905) seeds were planted by Mrs. Davis in her flower-garden in Ottawa, and the results were wonderful.

The plant grows about five and one-half feet high—not nearly so tall as the sunflower. It branches near the ground; the branches well filled with flowers. The stalks are thick at the base—two inches a fair average. The leaves retain the sunflower shape, being only less coarse and stiff. The flowers this year were very perfect; the first ones large, some of them four inches across. The

involucre and row of rays of the sunflower are retained, even to the paler yellow of the rays. They are, however, longer and narrower. The disk has now become full of ligulate flowers of a bright golden yellow. While seed was formed this season, it was not so abundant as in former years.

It was Mrs. Davis's plan to experiment another year before she offered descriptions of her new flower, which she called a chrysanthemum-sunflower, for publication. The flowers attracted so much attention that one of the Ottawa papers printed an account; then she generously offered seed to all who cared to grow the flower.

In August Mrs. Davis died, and I am indebted to her husband, Dr. Geo. W. Davis, of Ottawa, for the facts here recorded. While not making any pretensions to scientific skill or attainments, Mrs. Davis was an ardent lover of nature, especially flowers, and had several experiments under way similar to this one.

The first flowers were grown at Princeton, Kan., and these most perfect ones at Ottawa.

NOTES ON THE FLORA OF THE ROSEBUD INDIAN RESERVATION, SOUTH DAKOTA.

By ALBERT B. REAGAN, Rosebud, S. Dak.

THE Rosebud Indian reservation is situated in South Dakota, south of Big White river, and extends from about the middle south line of the state east to the Rosebud lands opened for settlement in 1904. It is bounded on the north by Big White river, on the east by Gregory county (the land opened up for settlement), on the south by Nebraska, and on the west by the Pine Ridge Indian reservation. The soil is sandy Loup Fork Tertiary, Miocene clays or Cretaceous black shales as one proceeds northeast across the reservation from its southwest corner. In the eastern part of this area and in the valley regions the Minnesota and east Nebraska flora prevails; in the medium elevated regions, that of the high plains; and on the high points and in the western part of the reservation, that of the Rocky Mountains. Many Canadian species are also met with. The country in early spring to the middle of the summer is a rose-flower region; hence the name, Rosebud. The Leguminosæ are also prominent flowers, but, though more numerous in species than the Rosaceæ, are less conspicuous. In the summer the Leguminosæ and the Evening Primrose family vie with each other. The predominating flowers of the fall season are those of the Compositæ. The grass family is represented by numerous species, which are themselves very variable. The trees are usually low and spreading, and are usually found only along the streams.

The following list of identified plants are the result of the author's observations during the spring, summer and fall of 1904. The work was carried on as time would permit, and, consequently, contains only a small part of the plants of the region.

The books used in identifying the plants were Wood's "Eastern Botany," Bessey's "Botany for High Schools and Colleges," Gray's "Lessons and Manual of Botany," and Coulter's "Manual of Rocky Mountain Botany."

The date in parentheses is that on which the first bloom of that respective plant appeared.

Ranunculaceæ:

Anemone carolinana Walt.
Numerous.

Delphinium azureum Michx. Larkspur.
Common.

Caltha palustris Linn. Marsh marigold.
Common in low places.

Cruciferæ:
Brassica arvensis. Mustard.
Only one plant was seen, on the Butte Creek wagon-road, one mile east of the Widow Dire's place (specimen not native).
Lepidium intermedium Gray. Peppergrass.
Dry places, yards, roadsides, etc.
Camelinia sativa Crantz. False flax.
Common.

Violaceæ:
Viola cucullata Gray.
Common in valleys.
Viola sagittata Ait. Arrow-leaved violet.
Common in damp places (April 6).
Viola delphinifolia. Blue violet.
Common (May 16).
Viola rotundifolia Michx. Yellow violet.

Portulacaceæ:
Portulaca retuso Engelm. Purslane.
Grows very profusely on dams and cultivated grounds.
Portulaca pilosa Linn.
Common, but not so profuse as the species above.

Malvaceæ:
Malvastrum coccineum Gray. False mallow.

Linaceæ:
Linum sulcatum Ridell. Wild flax.
Dry soil; common (June 1).

Geraniaceæ.
Oxalis corniculata Linn. Yellow wood-sorrel.
Common.

Vitaceæ.
Vitis æstivalis Michx. (same grape, var. bicolor, LeConte).

Sapindaceæ.
Negundo aceroides Moench. Box-elder.
Common along streams.

Anacardiaceæ.
Rhus glabra Linn. Sumach.
Rhus copallina Linn. Dwarf sumach.
Rhus toxicodendron Linn. Poison-ivy.
Rhus trilobata Nntt. (R. canadensis, var. trilobata, Gray). Sumach.
The four Rhus species above are very common. The poison-ivy is found in the valleys, even away from the timber.

Leguminosæ.
Baptisia leucophæa Nutt. False indigo.
Tephrosia virginiana Pres. Goat's-rue.
Tephrosia?
Astragalus caryocarpus Ker. Ground plum (May-June).
Astragalus pattensis Nutt. (May 14.)

Astragalus missouriensis? Nutt.
Astragalus cooperi Gray. (May 14.)
Astragalus?
Astragalus villosus Michx. (May-June.)
Orobus atropurpureus? (May 14.)
Psoralea tenuiflora Pursh.
Psoralea argophylea Pursh.
Psoralea esculenta Pursh.
Desmanthus brachylobus Benth.
Found principally in semiwet places.
Schrankia uncinata Willd. Sensitive brier.
Very common on middle uplands.

Rosaceæ.
Prunus, like P. chicasa.
Numerous in thickets along stream (May 5).
Prunus rosebudii. Rosebud dwarf plum. (New species.)
Plant erect or decumbent, growing singly or in bunches from a common root stalk, six inches to one foot in height; leaves obovate-lanceolate; flowers two to four together; fruit ovoid, nearly black when ripe, sour and astringent in taste; stone large. Rocks and sandy banks.
Prunus virginiana Linn. Choke-cherry.
Banks; numerous.
Rosa humulis Marsh. Wild rose.
Everywhere; species very variable, flowers ranging in color from white to scarlet (June 18).
Rosa woodsii Lindl.
Rosa arkansana Porter.
Rosa rubiginosa.
The last three species are found on the reservation, the latter probably escaped from cultivation.
Cratægus coccinea, var. macracantha, Dudly. Hawthorn.
Only one specimen of this species was seen, at the head of Horse creek, about eight miles southwest of the White Thunder day school.
Ribes oxyacanthoides Linn. Gooseberry.
Not common.
Ribes floridum L'Her. Wild black currant.
Common on banks of streams (April 26).
Ribes aureum Pursh. Buffalo currant.
Common (April 20).

Onagraceæ.
Œnothera biennis Linn.
Œnothera pinnatifida Nutt.
Œnothera albicaulis Nutt.
Œnothera coronopifolia Torr. & Gray.
Œnothera parviflora Watson.
These Evening primroses are the most common flowers in the late summer and early fall, the flowers of the Compositæ family excepted.
Gaura coccinea Nutt.

Mentzelia nuda Torr. & Gray.
Mentzelia ornata Torr. & Gray.

Cucurbitaceæ.
Cicyos angulatus Linn.
Banks and damp, wooded ground.

Cactaceæ.
Mamillaria vivipera Haw. Cactus.
Mamillaria missouriensis Sweet.
Opuntia rafinesquii Engelm. Prickly-pear.
These three species of cactus are found on the dry prairies and the broken country.

Umbelliferæ.
Polytænia nuttallii Dc.
Everywhere in early spring (April 1).
Peucedanum fœniculaceum Nutt.
Peucedaneum villosum Nutt. (April 1).

Compositæ.
Erigeron annuus Pers. Daisy fleabane.
Ambrosia artemisiæfolia Linn. Hogweed.
Xanthium strumarium Linn. Cockle-bur.
Too common.
Chrysanthemum leucanthemum Linn. Whiteweed.
A pernicious weed everywhere.
Krigia virginica Willd. Dwarf dandelion.
Very common, usually flourishing best in the middle uplands.
Helianthus annuus Linn. Common sunflower.
Helianthus orgyalis Dc.
Helianthus grosse serratus Martens.
Helianthus maumiliani Schrader.
Helianthus subcanescens Gray.
Solidago nemoralis, var. incana, Gray. Goldenrod.
Cincus lanceolatus Hoffm. Common thistle.
Common on broken ground.
Bidens bipinnata Linn. Spanish needle.
Few and scattering.

Lobeliaceæ.
Lobelia inflata Linn. Indian tobacco.
Common; used as Indian medicine.

Oleaceæ.
Fraxinus americana Linn. White ash.
Moist woods.
Fraxinus pubescens Linn. Red ash.
Common along streams.

Asclepiadaceæ.
Asclepias cornuti Descaisne. Common milkweed.
Asclepias verticillata Linn., var. pumula Gray.

Boraginaceæ.
Echinospermum floribundum Lehm. Beggar-lice.
Echinospermum lappula Lehm.
Echinospermum redowskii Lehm.
The three lice-weed species are very common in the wooded districts.
Lithospermum hirtum Lehm. Puccon.
Common.
Lithospermum angustifolium Michx.
Same as L. hirtum.

Convolvulaceæ.
Ipomœa purpurea Lam. Common morning-glory.
Escaped from cultivation (May 20).
Ipomœa leptophylla Torr. Wild morning-glory.
Common along watercourses.

Solanaceæ.
Solanum rostratum Dunal.
A common weed.

Verbenaceæ.
Verbena hastata Linn.
Verbena bracteosa Michx.

Labiatæ.
Isanthus cæruleus Michx. False pennyroyal.
Common.
Mentha canadensis Linn. Wild mint.
Common.
Hedonia hispida Pursh. Pennyroyal.
High, sandy points.
Salvia lanceolata Willd. Sage.
Very common.
Monarda punctata Linn. Horsemint.
Very common in the valleys.
Teucrium occidentale Gray.
Nepeta cataria Linn. Catnip.
Not common.

Plantaginaceæ.
Plantago major Linn. Common plantain.

Amarantaceæ.
Amarantus albus Linn. Tumbleweed.
Very common.

Chenopodiaceæ.
Chenopodium album Linn. Pigweed.
Cultivated grounds, everywhere.

Polygonaceæ.
Rumex acetosella Linn. Sheep-sorrel.
Rumex venosus Pursh.
Occasionally seen.
Rumex altissimus Wood. Pale dock.
Rumex crispus Linn. Yellow dock.
Rumex verticillatus Linn. Water dock.
Only one plant of this species was seen.

Aristolochiaceæ.

Shepherdia canadensis Nutt. Yellow buffalo-berry.

This species and the next are to be found in nearly all of the creek valleys of the reservation. The fruit is used much by the Indians. The whites also use it for making jelly, which they highly prize.

Shepherdia argentia Nutt. Scarlet buffalo-berry.

Utricaceæ.

Ulmus fluva Michx. Red elm.

Common along streams. It grows to be a large tree.

Ulmus americana Linn. White elm.

Not common.

Celtis occidentalis Linn. Hackberry.

Cannabis sativa Linn. Hemp.

Grows in barn-yards and cultivated bottom lands.

Humulus lupulus Linn. Hop.

Common along streams.

Cupuliferæ.

Quercus obtusiloba Wood. Post oak.

Common.

Quercus macrocarpa Michx. Bur-oak.

Banks. This species furnishes over half of the wood of the region.

Quercus macrocarpa, var. depressa, Engelm.

A dwarf species found in the deep, dry streams and ravines. It ranges in height from two feet to four feet.

Salicaceæ.

Salix amygdaloides Anders.

Salix rostrata Richardson.

Found on banks and at the water's edge along streams.

Salix longifolia Muhl.

This willow is found principally on White River flat. A bunch was found at the Ring Thunder day school.

Populus monilifera Ait. Cottonwood.

Borders of streams.

Populus heterophylla Wood.

Same as P. monilifera.

Coniferæ.

Pinus banksiana Lambert. Northern scrub-pine.

This tree is occasionally met with on the high points of the reservation.

Pinus pondorosa Dougl.

This tree is found on the high points and along the breaks of the Loup Fork (Arickaree) formation.

Juniperus virginiana Linn. Red cedar.

Robison bad lands and on all the other Miocene Clay bad lands of the reservation. It ranges from a scrub to a tree twenty to forty feet in height.

Iridaceæ.

Sisyrinchium angustifolium Mill. Blue-eyed grass.

Common (May and June).

Sisyrinchium anceps Cav. Blue-eyed grass.
Same as S. angustifolium.

Liliaceæ.

Nothoscordum striatum Kunth. False garlic.
Very common everywhere.

Yucca angustifolia Pursh. Bear-grass.
Very common, especially on the Miocene formation.

Polygonatum giganteum Deitrich. Great Solomon's-seal.
Common on low ground near the streams.

Smilacina stellata Desf. False Solomon's-seal.
Common in low, wet places (May 1).

Commelinaceæ.

Tradescantia virginica Linn. Spiderwort.

Juncaceæ.

Juncus effusus Linn. Common rush.

Typhaceæ.

Typha latifolia Linn. Cattail flag.

Gramineæ.

Bromus klamii Gray. Wild chess.

Setaria glauca Beauv. Foxtail.
Common in cultivated fields.

Cenchrus tribuloides Linn. Bur grass.
Sandy soil, found principally on the Arickaree formation.

Stifa viridula Tun. Feather-grass.

Agrostis vulgaris With. Redtop.
Scattering here and there.

Bouteloua oligostachya Torr. Grama-grass.
Found only in patches.

Buchloe dactyloides Engelm. Buffalo-grass.

Elymus canadensis Linn. Wild rye.

Poa tenuifolia?. Redtop buffalo-grass.
Very common.

Chrysopogon nutans Benth. Wood-grass.

Festuca ovina Linn. Bunch-grass.

Agropyrum repens Beauv. Bluejoint.

Calamagrostis canadensis.
Common in wet places.

Equisetaceæ.

Equisetum arvense Linn. Horsetail.
Ring Thunder Springs and in all the low, swampy places of the reservation.

Agaricus compestris.

Lycoperdon gigantum.

VI.

MATHEMATICAL AND PHYSICAL PAPERS.

"VARIATIONS OF LATITUDE."
By E. MILLER, University of Kansas, Lawrence.

"THE GENESIS OF GOLD IN MINERAL VEINS AND PLACERS."
By J. T. LOVEWELL, Topeka.

"THE GAS-ENGINE IN THE COMMERCIAL DEVELOPMENT OF KANSAS."
By P. F. WALKER, Lawrence.

"NOTE ON CERTAIN FORMULAS FOR THE DESIGN OF REENFORCED CONCRETE BEAMS."
By A. K. HUBBARD, Lawrence.

"EXAMINATION OF COAL-DUST AFTER EXPLOSIONS IN MINES OF SOUTH-EASTERN KANSAS."
By EDWARD BARTOW, University of Illinois, Urbana.

"THE FOUCAULT EXPERIMENT."
By J. T. LOVEWELL, Topeka.

"A DEEP WELL AT EMPORIA."
By ALVA J. SMITH, Emporia.

"THE INTERPRETATION OF INDICATOR DIAGRAMS."
By CHARLES I. CORP, Lawrence.

"A BIT OF ENGINEERING AT MOUNT VERNON."
By M. L. WARD, Ottawa University.

VARIATIONS OF LATITUDE.

By E. MILLER, University of Kansas, Lawrence.

THERE was published in the *Astronomical Journal* of November, 1891, an article on "The Variation of Latitude." Its author was Mr. S. C. Chandler, an American amateur in astronomy. The article attracted the attention of the astronomical world, and at once was subjected to fierce criticism from almost every quarter. To-day, however, the question is no longer an open one, for those who assailed it have, one by one, accepted it as established beyond a doubt.

In order to make clear what is to be said on the variation of latitude, it is necessary to go back about 200 years, to ascertain what was known and what was done along the line indicated by the title of this paper. In 1693 there was born, in Sherbourn, England, a child, James Bradley by name, who was to become one of the greatest of astronomers. He was one of those who are not content simply to amuse themselves with a telescope, but rather had the ambition to do earnest work, and the spirit to choose a problem which his predecessors for more than a century had failed to solve.

The Copernican theory that the sun is the center of the solar system and that the earth moves round the sun established a corresponding apparent change in the places of the stars. The absence of any appreciable change in the position of the fixed stars, when observed at opposite extremities of the earth's orbit, was one of the earliest objections, as well as the most serious one, that had been urged against the earth's motion; and it was always considered that the detection of such a change by observation would furnish absolute proof that the earth is not the center of the solar system. In the attempt to detect the annual parallax of the fixed stars, Bradley made his famous discovery of the aberration of light. Its discovery is universally regarded as one of the most important advances ever made in the field of astronomical science. The sagacity of Bradley in the establishment of this law, as well as in the detection of its physical cause, entitles him to a place among the greatest philosophers of ancient or modern times.

While at work investigating the phenomenon of aberration, Bradley found that some stars near the equinoctial colure had a greater

change of declination than a mean annual precession of fifty minutes would give. But on observing stars near the solstitial colure, the change of declination was found to be less than the quantity due to the same value of precession. During an interval of five years, he found some of the stars near the solstitial colure had changed their declination nine or ten minutes less than the amount due to a precession of fifty minutes, while others near the equinoctial colure had an equal change of declination in the opposite direction. Bradley was led to ascribe the phenomenon to an oscillation of the earth's axis, brought about by the disturbing action of the moon upon the earth's equator. He saw that the apparent movements of all stars were in this case the same, and he knew that a movement of this kind can be referred not to the stars themselves, but to the plumb-line from which their directions are measured. He had thought out the possible causes of such a movement of the plumb-line or of the earth itself, and that there might be a nutation which would go through a cycle of about nineteen years, the period of revolution of the moon's nodes.

At the end of nineteen years of observation Bradley found his conclusions verified, and his second great discovery, that of nutation, was established. Had he lived longer, a third great discovery might have crowned his efforts. He had presented to the astronomical world the discovery of the aberration of light; he had discovered the nutation of the earth's axis; he had found the physical causes of these two phenomena; and with a little more opportunity he might have added another great discovery, namely, the variation of latitude. The axis of the earth may move in one or two ways: either it may point to a different star, remaining fixed relatively to the earth, as in the case of nutation, or it may actually change its position in the earth. This second movement was not discovered until a century and a half had elapsed after the death of Bradley. But he was on the track that would have led him to its discovery. When he had fully established the principle of the nutation of the earth's axis, he found that there was concealed somewhere in his new-found theory another principle or residuum.

Now, as to the change of position of the earth's axis in the very body of the earth itself. There is a certain star in the northern heavens called the pole star, and at any particular place in the northern hemisphere of the earth this star is constantly seen at a definite height above the horizon, which is the latitude of the place. With a telescope, the pole star is found to be not absolutely stationary, but describes a small circle in the heavens every twenty-

four hours. The axis of the earth about which it rotates points to the center of that little circle, and any change can therefore be determined by observing the motions of the pole star. It is found, too, that the size of the circle increases or diminishes, thus indicating that the earth's axis is pointing farther away from the pole star, or nearer to it. This movement is due to precession, as has been known ever since the days of Hipparchus. The circle described by the present pole star is now getting smaller, but in the course of years it will increase in size, until after thousands of years it will cease to be the north star. Other stars, one succeeding the other, each at about twenty-three and one-half degrees from the pole, will become in turn the pole star.

Again, the center of the circle may change its position, and no longer be at the same height above the horizon of any given place. If this is true, then the earth's axis must be shifting in the earth itself; in other words, the north pole is not remaining in the same place. If the change in position should ever become a large one terrestrial climates would be subject to very great changes; but the truth is that the changes are small and the effect on climate is scarcely appreciable. Fifteen or twenty years ago no one believed that the north pole of the earth moved. Even the finest astronomical observations of that time failed to detect any such movement. Yet we have reached a point where the facts clearly show that the north pole does move—not very much, but still to an extent that is easily measured by astronomical observations.

Mr. Chandler found that there is a revolution of the earth's pole in 427 days, from west to east, with a radius of thirty feet, measured at the earth's surface. He assumed, for the purpose of statement, that this is "a motion of the north pole of the principal axis of inertia about that of the axis of rotation; the direction of the former from the latter lay towards the meridian of Greenwich about the beginning of the year 1890. This, with the period of 427 days, will serve to fix approximately the relative positions of these axes at any other time for any given meridian." This was in flat contradiction to all accepted views. The only period in which the earth's pole could revolve was believed at that time to be ten months. The radius of its path had been declared to be insensible, and now comes Mr. Chandler affirming that the period was a variable one, and that the path had a radius of thirty feet.

In confirmation of his theory, an examination of the observations of a German astronomer, of Berlin, furnished Mr. Chandler another fact, namely, when the Cambridge, United States, latitudes

were the smallest, those of Berlin were the largest; that is to say, if the north pole moved nearer America, it must move further from Europe; and, on the other hand, if further from America, then nearer Europe. There was something perplexing about these movements, as they had been known for a long time, but no satisfactory solution had been given. Mr. Chandler solved the problem, and the difficulties were removed.

To show that there is a deviation of the earth's pole from its average position, two tables, prepared by Chandler, showing the distances of the earth's pole, in feet, from its average position, are herewith given, each representing a year's observations. The signs plus and minus indicate opposite directions of displacement. The first table was made at Washington, D. C., and the other at Pulkowa, near St. Petersburg.

Washington.		*Pulkowa.*	
December, 1864	−28 feet.	July, 1865	−18 feet.
March, 1865	− 1 "	September, 1865	+ 3 "
June, 1865	+15 "	November, 1865	+26 "
August, 1865	+22 "	February, 1866	+18 "
October, 1865	+11 "	June, 1866	−11 "
December, 1865	−17 "	July, 1866	−16 "

The figures are not exact in every case, but the error in them is always a very small one. Every expert astronomical observer knows how difficult a matter it is to obtain the position of the earth's pole to within a foot.

Mr. Chandler's investigation of the results reached by other astronomers, and comparing them with his own, arrived at the conclusion that there was, besides the vibration of the earth's axis in the body of the earth, also an increase in the period of polar revolution. At the time of Bradley's observations the period was shorter by about two months than it is now. Whether this movement is subject to a periodicity, reaching at one time a maximum and then a minimum, is not yet determined. But it is certainly known that at times there are very irregular movements, due to some cause or other, followed by others that are subject to a periodicity.

Chandler says: "Another characteristic which has struck my attention, although somewhat vaguely, is that the variations in the length of the period seem to go hand in hand with simultaneous alterations in the amplitude of the rotation; the shorter periods being apparently associated with the larger coefficients for the latter."

Almost all of the series of observations of any extent which

have been examined are peculiar in that they manifest the periodicity quite uniformly and distinctly for a number of years, then for a while irregularly and obscurely.

Simon Newcomb, one of the greatest of living astronomers, in his discussion of Chandler's theory, writes as follows:

"Mr. Chandler's remarkable discovery, that the apparent variations in terrestrial latitudes may be accounted for by supposing a revolution of the axis of rotation of the earth around that of figure, in a period of 427 days, is in such disaccord with the received theory of the earth's rotation that at first I was disposed to doubt its possibility. But I am now able to point out a *vera causa* which affords a complete explanation of this period. Up to the present time the treatment of this subject has been this: The ratio of the moment of inertia of the earth around its principal axis to the mean of the other two principal moments admits of very accurate determination from the amount of precision and nutation. This ratio involves what we might call, in a general way, the solid ellipticity of the earth, or the ellipticity of a homogeneous spheroid having the same moments of inertia as the earth.

"The question now arises whether Mr. Chandler's result can be reconciled with dynamic theory. I answer that it can, because the theory which assigns 306 days as the time of revolution is based on the hypothesis that the earth is an absolutely rigid body. But, as a matter of fact, the fluidity of the ocean plays an important part in the phenomenon, as does also the elasticity of the earth. The combined effect of this fluidity and elasticity is that if the axis of rotation is displaced by a certain amount, the axis of figure will, by changed action of the centrifugal force, be moved toward coincidence with the new axis of rotation. The result is, that the motion of the latter will be diminished in a corresponding ratio, and thus the time of revolution will be lengthened. I think the result of investigation will be that the rigidity derived from Mr. Chandler's period is as great as that claimed by Lord Kelvin from the phenomena of the tides."

Mr. Chandler himself says: "It is unnecessary for the purpose of disposing of objections to insist that it is not sufficient to show that the observed variations, attributed to the unsteadiness of the earth's pole, are near the limit of precision attainable in linear differential measures, and in the indication of the direction of gravity by means of the air-bubble of the level; or to show that there are known variations in divided circles and in levels, dependent on temperature and seasons. Nor need we even urge the fact

that a large portion of the data which have been utilized in the present researches on the latitude were derived by methods which dispense with levels, or with circles, a part of them indeed with both, and yet that the results of all are harmonious. On the contrary, let us admit, although merely for argument's sake, that all the known means of determining the direction of gravity are subject to a common law of periodical error which vitiates the result of astronomical observation, obtained by whatever methods, and in precisely the same manner. Now, the observed law of latitude variation includes two terms, one a period of fourteen months, and the other of twelve. Since the phases of the first term are repeated at intervals of two months in successive years, and hence in a series of years come into all possible relations to conditions of temperature dependent on season, the argument against the reality of the fourteen months' term absolutely fails."

Heretofore the observations made by astronomers in Europe and America, in all of which there was some puzzling error, were immediately rectified when Mr. Chandler applied his new rule to them. The constant of aberration has been wonderfully improved, but there is room yet to secure greater accuracy.

Again, if the axis of the earth is making small oscillations of this kind, there should be an effect upon the tides. The ocean should feel the swinging motion of the earth's axis in some way. The tidal registers show that there is a distinct effect. The rise and fall of the tide are only a few inches, but they are evidences of an irresistible character that the earth is turning around in an unbalanced vibration. The vibration at one time is waxing and at another waning.

In conclusion, it may be said that in the consideration of this subject we find that when Bradley, 160 years ago, began to work out the problem of parallax, he was led to the discovery of the "aberration of light," and finding that an uncertain element persisted in presenting itself at every turn of his work, he was led to the discovery of the nutation of the earth's axis. But even at this point he found another difficulty remaining over. Death cut short the work of the great astronomer. Twenty years ago the work was resumed by an American. Now it is an accepted fact that not only does the earth's axis spin around, according to the theory of nutation, but there is another and stronger motion of the earth's axis, and that is, that there is an actual change of the position of the earth's axis in the earth itself, causing the latitude of the earth to change at every point on its surface.

THE GENESIS OF GOLD IN MINERAL VEINS AND PLACERS.

By J. T. LOVEWELL, Topeka.

IN our limited sphere of observation we can know but little of the internal structure of the earth. Assuming it once to have been a molten liquid mass, it is natural to conclude that the denser constituents would be grouped nearest the center, and as the earth cooled, and as rifts were made by contraction of the solid crust down to the liquid interior, the molten rock extruded through these cracks would contain more of the heavy metals. Were the fissure deep enough the outflow might be metals like gold or platinum, or even heavier substances, unknown on the earth's surface.

The hypothesis of a liquid interior has little to support it, and whatever may be the temperature it is certain that the earth's interior is a mass of great rigidity, and we can form little conjecture how its elements are combined and grouped.

The fact of rifts in the crust may be admitted, and that these were ways of exit of a molten magma which filled the crevices and flowed out as it does to-day in volcanoes.

But these fissures are filled not only with igneous rock but with materials crystallized out of solutions. One of the commonest of these crystallized substances is quartz, either alone or intermixed with oxides, sulfides, etc., of various metals, or with the metals uncombined, as gold and silver. The solvent which carried this silica and these metals is doubtless water, which comes nearest of any liquid to being the universal solvent. In explaining earth problems we must always keep in mind the ever-present water, which, first enveloping the earth as a vapor, must have been continually exerting its solvent powers on whatever was beneath and around it. Not only does it act on surfaces but it penetrates the interiors of substances, and its energy is increased by the gases, such as chlorine, with which it may be saturated, and by the high temperature, at which it must always have existed.

If we start now with the situation when the igneous rocks and crystallizations fill the fissures and outcrop on the surface of the earth, we find the water acting in another role. It is now to grind down the surface by glacial action, to plow out the valleys by erosion, and to sift the fine from the coarse, the heavy from the light, till the deposits are brought to their present condition. The gold

deposits of Cape Nome, of the Rand and of innumerable placers are the results of these actions of the waters in their grinding, carrying and sifting capacity.

As already intimated, the gold found in quartz fissure veins may have been deposited with the silica from the water.

We may inquire, then, whether the seas, which cover a large part of the earth's surface, still carry gold in solution.

On authority of the English chemist, Liversidge, a ton of sea-water contains on an average one grain of gold. If this be true, we can calculate the amount of gold in the waters of the sea. Chamberlain and Salisbury, in their recent text-book on geology, estimate the quantity of sea-water at 1300 quadrillion tons. This, then, is the number of grains of gold spread abroad in the sea. The number of grains in a cubic foot of gold is, approximately, 8,312,500. The total number of grains, divided by this, gives 15,639,218,045, the number of cubic feet of gold dissolved in the waters of the sea. This more than equals a cube of gold 2500 feet on each edge.

This universal distribution of gold in water is accompanied by its almost equally general occurrence in mineral deposits, and perhaps accounts for the latter fact. In studying the physical aspects of the earth, we are apt to look upon it as a completed structure, and we think of the great changes revealed to us in geology as having no counterpart in the present time. A moment's reflection will convince us that earth changes are yet going on by which the structure may be altered as much as it has been in past eons.

As to the possibility of gold veins and placers being even now in the process of formation, we have some evidence to support such a hypothesis. In the University of California Bulletin, vol. 4, No. 10, John A. Reid discusses the origin and genesis of the Comstock lode. He treats of the geological formation and development of the Comstock lode mines, and comes to certain conclusions as to the part water has played in the "bonanzas" of these rich veins. The primitive vein of gold-bearing mineral has had the gold leached out of it, as it were, to be redeposited in secondary veins, which become thereby extremely rich in gold, and this investigator thinks the process may be still going on in the deeper levels of the mine. He finds by analysis of the vadose water of the mine a percentage of gold greater than sea-water contains, and the deposit of the metal in newly opened fissures is easily seen possible.

What is going on in the Comstock mine may have its counterpart in other veins, known or undiscovered, and suggests the

thought that in future ages gold veins may be worked where the gold at this present time is not deposited.

In this paper the inquiry has been limited to gold, but it is easily seen that similar conclusions could be reached respecting other metals, and that water has had an important part in determining the location and condition of ore deposits. We can find near the surface of the earth all the material needed to supply the mineral veins, and it is unnecessary to suppose that the heavy metals must have come from great depths.

THE GAS-ENGINE IN THE COMMERCIAL DEVELOPMENT OF KANSAS.

By P. F. WALKER, Lawrence.

THE state of Kansas is well situated with reference to the great producing sections of the country for the establishment of important manufacturing interests in cotton and woolen fabrics, boots, shoes, and leather novelties, and has itself mineral resources of various kinds not yet fully developed, and which are now being shipped as raw rather than as finished products. With these advantages of location, and native resources in material to be wrought upon, are valuable deposits of coal, oil and gas for fuel, building materials of the very best quality, a soil capable of supporting a far greater population than the liveliest imagination has pictured, and a climate well suited to attract the earnest home-seeker. The question, then, may be seriously considered if a fair proportion of these raw materials may not well be expected to be worked upon here in the not far distant future, instead of their being shipped far into the Northern and Eastern states and then back again, in great part for final consumption by those who are working to send food on its long journey to pay the debt.

There are three conditions which must be favorably met before business interests of the kinds indicated can be successfully established. When once it is demonstrated that they are favorable here in Kansas, the necessary capital will come unbidden, and there will set in a new era in industrial development. These three conditions are: First, efficient and economical transportation facilities, both to the mills and to the markets; second, a supply of competent labor; and, third, an abundant and economical source of power. Other special conditions may sometimes arise, as, for instance, the necessity for a supply of clear water, to be used in the manufacturing process; but the three general conditions must always be met.

In respect to transportation the state is peculiarly fortunate, and better conditions could hardly be desired. This is especially true because of the fact that the power to be depended upon is not scattered over the country at falls in the watercourses, but the mills may be located at will on trunk railroad lines.

The labor condition is a serious one. Practical mill men have expressed the opinion to the writer that this is the greatest obstacle

to be overcome in locating the textile mills and boot and shoe manufactories in a new country. Operatives must acquire a certain skill, requiring time and patience, and a tolerable acute intellect, and the surroundings in which they work are trying to the constitution, particularly for those who have been accustomed to an outdoor life. Those who have been reared in the atmosphere of the mills—often too literally so, in the absence of restrictions on child labor—make competent workers, but they shrink from going into a distant field, where the number of mills is small and changes of situation not easily effected, since they are inclined to make frequent changes. In the movement to establish cotton-mills in the Southern seaboard and Gulf states, which has been successful, dependence has been placed on the white people of the mountain sections to supply the demand for labor. It seems doubtful if there is a class in Kansas that will take kindly to the work, and it will take time to develop a mill population.

In the consideration of power we come to the real subject-matter of this paper. The demand for power in nearly all of the industries referred to is considerable, and serious variations in the cost of power affect the dividend-paying possibilities to a considerable extent. For illustration, we may take a cotton-mill of 50,000 spindles, which will produce 25,000,000 yards of dress goods of average weight per annum, and compare power costs when driven by water power and when driven by steam-engines. This mill will require an invested capital of about $750,000. It will require 1800 horse-power to run the machinery. The average cost of water power, when available for direct application, is about $12.50 per horse-power per year at the New England mills, giving a total annual cost of $22,500. For the steam-driven mill we will assume a first-class type of compound condensing engine, good boilers, and a high-grade coal, costing $5 per ton delivered on the boiler-room floor. The first cost of installation will be about $52 per horse-power—not materially different from that of the water plant. Allowing five per cent. of cost of machinery to cover the items of depreciation and repairs, a fuel consumption of two and one-fourth pounds of coal per horse-power per hour, and $3000 per year for labor in the engine- and boiler-rooms, we have, for a year of 300 days of ten hours each, a total cost of nearly $38,000, which is $15,500 more than the cost of water power. This difference is 2.1 per cent. of the total investment, and is a direct inroad on dividends, being enough to effectually prohibit operations in many cases.

Now, then, what are the possibilities here in Kansas?

Before leaving the question of water power it will be well to consider briefly one phase of the matter that may become of importance. Water-power privileges are not numerous in Kansas, but there are a few points where power in large amounts could be produced, and from it electric power be generated directly and transmitted at high voltage to convenient points for the establishment of mills, where it can be used through the medium of electric motors. This method of power utilization is now being extensively employed throughout the country, and a plant is now in process of construction in the southeastern part of Kansas to supply power to three different towns in that section. With this form of service, assuming that the central plant furnishes power to the equivalent of three mills like our type, and that power is transmitted twenty-five miles, the increase in the first cost of the mill would be about $70,000, this being approximately one-third of the cost of the electrical machinery and building at the central station, the transmission line, and motors to run the mill. The increase in the actual cost of the power will be made up of two items: First, the additional water power to make up for the losses in changing to electrical and back to mechanical power, and the direct loss in transmission; second, depreciation and repairs on the electrical equipment, which will be a larger amount than in the case of the steam machinery. Taking the power loss as twenty per cent., we have 360 horse-power at $12.50, or $4500, in the first item. Depreciation and repairs may be taken at six per cent. on $56,000, which is the cost of the electrical machinery alone, giving $3360 in the second item. The total increase of power cost over that for water power applied directly is thus $7860, *or about one-half that for steam power.* Dividends must in this case be paid on an investment nearly ten per cent. greater, however, so that the actual decrease in the rate will be nearly *1.5 per cent.* Undoubtedly this figure can be bettered by the use of electricity for other purposes than running the machinery, or by sale to other parties. This is true particularly in those establishments where portions of the machinery are run during only a part of the time, since individual motors may be used on the machines or groups of machines, and so save the power to drive long lines of idle shafting. In fact, it is often found desirable to use this electric-motor system when the power plant is located directly at the operating plant, in order to save driving so much idle machinery, and when there are several buildings this system is by far the best possible in the great majority of cases, whether water or steam is the prime power.

In this state, however, the power to be depended upon is that transformed from the heat energy stored in the fuels that are available through the agency of some form of heat engine. There are two general classes of these engines. In one the heat of the fuel is applied to some liquid, usually water, in a separate vessel, or boiler, and the vapor thus formed is led to the working cylinder of the engine, where it gives up its heat to produce the energy of moving machine parts. The steam-engine with its boiler is the only practical example of this class. It may use any fuel, as coal, oil, or gas, that will supply the heat. In the other class the fuel is taken into the working cylinder of the engine proper with a supply of air, and there burned. The heat so generated is applied directly to the air present, which with the burned gases forms the working fluid. Of this class the most prominent types are the gas-engine, the oil-engine (using crude petroleum directly), the gasoline-engine, and the kerosene-engine. They are designated as internal-combustion engines.

The fuel used by the gas-engine may be natural gas, artificial gas from the producer used for general gas production, or that from a special form of suction-gas producer, in which the engine in drawing in its fresh charge of air and gas furnishes the draught necessary to maintain combustion in the producer. This last system is becoming popular, due to its economy in operation and the compactness and unity of the plant. Several electric generating plants using this system have been installed in this state during the last few years, and more are in process of erection. The fuel used in the producers now in operation is anthracite coal, but at least one company is now perfecting plans for a producer adapted to the use of the bituminous coal mined in this section of the country. This system is of the greatest importance, since it insures the permanence of the gas-engine so long as the coal supply holds out. Natural gas is good where it may be had and as long as it lasts, but it can hardly be considered as a permanent fuel, and could not be accepted as fulfilling the condition for an abundant source of power.

The oil-engine, using crude petroleum directly as a fuel, has been brought out in the United States in a really satisfactory form by only one company. In this form it is a German design, controlled by the Diesel Motor Company, of New York, and built by the American and British Manufacturing Company in Providence, R. I. In operation, the oil is pumped under high pressure into the engine cylinder, in which air has been compressed to a pressure of 500 pounds to the square inch. The oil is forced in against this

pressure in such a manner that it is sprayed on entering, and the high temperature produced in the air by the compression is sufficient to ignite it. Its cycle is the nearest approach to the ideal cycle first demonstrated by Carnot, the distinguished French scientist and engineer, that has ever been secured in engineering practice. The engine is very efficient and is meeting with a good demand, mostly for use in electric-generating plants, which is the most exacting service to be met. So long as the petroleum supply remains abundant it must be considered as an important prime mover, and in this respect is far superior to the gas-engine using natural gas. Since the fuels used in the two remaining types of internal-combustion engines, namely, gasoline and kerosene, are products of petroleum and comparatively expensive, those forms are not to be considered, excepting at isolated points where small powers are needed.

As machines these two internal-combustion engines which we may consider seriously in the present connection, namely, the gas- and oil-engines, are compact and well constructed, occupying small space in proportion to the power. All are probably familiar with small types of the gas-engine, and it may be that many have in their minds the idea of a small, noisy, and, perhaps, "cranky" affair, which features are sometimes characteristic of the type. An inspection of a large modern engine would do much to dispel that idea. The small engine usually works with but one effective impulse from the combustion or explosion of the gas in two complete revolutions, according to the so-called Otto or four-stroke cycle. This necessitates a very heavy balance-wheel, and increases the difficulties of governing the speed, but it is very generally accepted as the best method of securing efficient utilization of the heat energy of the gas. When large powers are necessary, two or more engines are usually connected to the same shaft, and set so that their impulses alternate, thus securing more uniform expenditure of energy, and making possible extremely accurate governing of the speed. Both vertical and horizontal types are successfully employed.

The latest designs of large power engines by the Westinghouse Machine Company are strikingly similar in general appearance to some makes of tandem compound high-speed steam-engines, excepting for the nature of the valve gear. They have two cylinders in line, with pistons on the same rod, and both cylinders double acting. Hence, instead of having but one impulse in two revolutions or four strokes, each cylinder gives one impulse every two

strokes, and, both together, an impulse for each stroke, or two for each revolution. This places it on a par in this respect with a single-crank steam-engine, and the governing features are good for any service. In the largest sizes it is made still better, however, by having two cranks and rods, with two pairs of cylinders, the cranks being set at ninety degrees with each other, by which method four impulses per revolution are secured. Engines of the single-crank type are made in powers ranging from 200 to 2000 horse-power, and of the double-crank type from 400 to 4000 horse-power. Since very high temperatures are produced in all gas-engines during combustion, sometimes as high as 2800 or 3000 degrees Fahrenheit, which is above the melting-point of cast iron, water circulation in all parts exposed to the heat is necessary, and in the double-acting engines this cooling of the enclosed pistons presents some difficult features in design.

The Diesel oil-engine is built in vertical form, with either two or three cylinders and sets of moving parts, and in general appearance resembles a marine steam-engine. Each cylinder is single acting, giving one impulse in two revolutions, so that the engine as a whole gives either one or one and one-half impulses per revolution, which insures good governing features. The maximum temperature in the cylinder is not far from 1400 degrees Fahrenheit, which is that resulting from the preliminary compression, since the admission of fuel oil is so regulated that it burns during expansion without rise in temperature. The engine is built at present in sizes ranging from 75 to 225 horse-power, but may be readily doubled up on the same shaft and so double the range of power.

As efficient converters of heat into mechanical energy these engines may well be studied in comparison with the steam-engine, since it is with the latter that they come into competition. In this comparison a compound condensing steam-engine will be taken as the type representing the class in large manufacturing plants and for power-station service. A good type of steam-boiler will utilize from 70 to 75 per cent. of the heat in the fuel, as equipped and operated in first-class establishments. The engine of the kind in question will utilize from 14 to 15 per cent. of the heat coming to it in the steam in general service, or 10 to 11.2 per cent. of the total heat value of the fuel burned. The bulk of the remainder of the heat is carried away in the cooling water in the condenser and up the flue from the boilers. The gas- and oil-engines, on the other hand, work with a thermal efficiency of from 17 to 25 per cent., with possibilities of still better results.

As desirable forms of prime movers in commercial plants the gas- and oil-engines must be subjected to complete analysis that shall include all conditions of first cost, depreciation, repairs, and labor, as well as fuel cost. This we will now proceed to do with our typical cotton-mill.

A single gas-engine of 1800 horse-power, to use natural gas, may be purchased for about $43 per horse-power; foundations will cost about $7; making the total cost of the engine, erected, $50 per horse-power, or $90,000. This is somewhat less than the average first cost of a water-power plant, but the difference is not likely to be enough to influence appreciably the total investment in the mill. Depreciation may be taken at four per cent. and repairs three per cent. on $90,000, giving $6300 annually. Labor for attendance, one man, at $750 per year. Gas consumption will be about ten cubic feet per horse power per hour, or 54,000,000 cubic feet per year of 3000 hours. With gas at 25 cents per 1000 cubic feet, the fuel bill will be $13,500, and hence the total annual cost of power, $20,550. This, when compared with the preceding calculations, giving $22,500 for water power and $38,000 for steam power, shows well for the gas-engine. When installed with a suction producer, using coal for fuel, conditions will be different. Actual figures for cost of producers of this capacity are not available, but $10 per horse-power will be a safe figure, which, with $2000 added to the cost of the engine to provide for the slightly increased size necessary when used with the suction producer, makes the total cost of the apparatus $110,000. It will be assumed that Arkansas anthracite coal will be used, at $6 per ton, and that the rate of fuel consumption will be 1.25 pounds of coal per horse-power per hour, which is a liberal figure. This gives 3375 tons of coal burned per year, at a cost of $20,250. Depreciation and repairs will be increased to seven per cent. of $110,000, or $7700, and labor increased by two men, at $450 each per year, making total labor $1650 per year. This makes the total cost of power $29,600 per year, or $7100 more than the cost of water power. This excess is, however, but forty-five per cent. of that occurring with the use of steam, and is $760 less than that with water power with electrical transmission and motor drive. As already noted, however, the power cost with the latter system may be reduced under favorable conditions; so it may fairly be stated that costs are about the same for the hydro-electric system and the gas-engine with suction producer.

The first cost of the gas equipment is $50,000 less, however; so that there would be a difference in dividends in its favor of over

0.5 of one per cent., while there would be a difference of less than one per cent. between it and directly applied water power in New England. Freight differences on raw materials would probably more than counterbalance this difference, so that the cotton-mill in Kansas will be on the same plane with the New England mill as betwen power cost and freight, while with natural gas at 25 cents per 1000 cubic feet it will be better off on power alone by 0.2 of one per cent. in dividends.

It is almost useless to make calculations for power costs from crude petroleum as a fuel. The price is subject to great fluctuation, and if it should be adopted to any very considerable extent in manufacturing plants it is extremely doubtful if the supply would be adequate, in view of the great demand for the lighter distillates, and in any case the price would greatly increase. Under present conditions in Kansas it offers great advantages as a substitute for coal, especially when used in the oil-engine.

In point of economy in fuel consumption there can be no doubt as to the superiority of the gas- and oil-engines over the steam-engine. This does not mean that the latter is to be at once relegated to the junk heap, however. At the present stage in the development of the internal-combustion engine, its small financial advantage, as shown in the preceding calculations, is often offset by the practical usefulness of steam in auxiliary service, to say nothing of the advantage accruing from the familiarity of operating engineers with the older type.

As it has taken a century and a quarter to develop the steam-engine since it first assumed its practical form in the hands of Watt; so must more time be given to perfect this later type of prime mover which first appeared in really successful operation in 1876. The gas-engine is now passing through a transitional period, while it is coming into prominence as a real factor in the larger business interests of the world. The new form of Westinghouse engine already described shows the manner in which the type is progressing, following instinctively the path of progress marked by the steam-engine, but standing as a more economical machine. It is moving far more rapidly than did the steam machine, and even now, as the latest and most improved steam motor, the turbine, is being perfected and successfully established as a positive step in advance, prominent European scientists and at least one of the prominent engine-building companies of this country are working on the gas-turbine, which we may expect to see making its appearance in the

near future as the latest and most refined result of scientific engine designing of the age.

The commercial development of Kansas of which we speak belongs to the future, perhaps not far distant. The present narrow margin in favor of the gas-engine will be made larger as time goes on, principally by a reduction in the fixed charges for depreciation and repairs, resulting from standardized forms and lower first cost, since the present prices for the engine are abnormally high. Operating engineers are gradually becoming acquainted with it, which in itself will insure increased favor, and there can be no doubt but that in this form of motor Kansas, and other similarly situated states, will find the source of power that will serve in the permanent advancement of the manufacturing interests.

NOTE ON CERTAIN FORMULAS FOR THE DESIGN OF REENFORCED CONCRETE BEAMS.

By A. K. HUBBARD, Lawrence.

IN chapter II of the book on Reenforced Concrete, by A. W. Buel and C. S. Hill, some formulas and deductions are given which are incorrect. It is the object of this paper to point out the mistakes in these formulas and deductions, and to illustrate the errors involved by numerical examples.

Before proceeding to a consideration of the formulas, it will be well to notice the assumptions on which the formulas are based. It is not proposed to enter into any discussion concerning the correctness of these assumptions:

1. The strain of any fiber is directly proportional to the distance of that fiber from the neutral axis of the beam.

2. The stress in any fiber is proportional to its distance from the neutral axis.

3. Any variation of stress or strain near the reenforcement is neglected.

Referring to figure 1, the author uses the following notation:

M = bending moment in inch-pounds.
l = length of beam in inches, center to center of supports.
h = depth of beam in inches, out to out concrete.
b = breadth of beam in inches.
A = total area of cross-section of beam = hb.
A_s = area of steel reenforcement in tension.
A_s^1 = area of steel reenforcement in compression.
$A_c = A - (A_s + A_s^1)$ = area of concrete.
x = distance from neutral axis to outer compression fiber of concrete.
y = distance from neutral axis to outer tension fiber of concrete.
u = distance from neutral axis to outer compression fiber of steel.
z = distance from neutral axis to outer tension fiber of steel.
t = distance from neutral axis to center of steel sections in compression.
v = distance from neutral axis to center of steel sections in tension.

$y = z + d$; $x = u + d^1$; $h = x + y$; $h^1 = u + z$; $h^{11} = t + v$; $y = v + d_1$; $x = t + d_1^1$.

I = moment of inertia of reenforced beam about its neutral axis $= I_s + I_c$.
I_s = moment of inertia of steel about neutral axis of beam.
I_c = moment of inertia of concrete about neutral axis of beam.
E_s = modulus of elasticity of steel.
E_c = modulus of elasticity of concrete.
$e = \frac{E_s}{E_c}$.
f_s = maximum intensity of tensile stress in steel.
f_s^1 = maximum intensity of compressive stress in steel.
f_c = maximum intensity of tensile stress in concrete.
f_c^1 = maximum intensity of compressive stress in concrete.
L_s = load sustained by steel.
L_c = load sustained by concrete.
s = proportion of load sustained by steel.
c = proportion of load sustained by concrete.

The steel reenforcement may consist of one or any number of bars, of any cross-section on both sides of the neutral axis or on the tensile side only.

After stating a number of formulas relating to the bending moment on beams, which have no bearing on the subject of this paper, the author gives these formulas without any deductions:

(*1*) $$y = \left\{ \frac{bh^2}{2} + \left[A_s d_1^2 + A_s^1 (h - d_1^1)^2 \right] (e-1) \right\} + \left[A + (A_s + A_s^1)(e-1) \right]$$

(*2*) $$x = h - y$$

(*3*) $$z = y - d$$

(*4*) $$u = x - d^1$$

(*5*) $v = y - d_1$ where $d_1 = d +$ radius of steel.

(*6*) $t = x - d_1^1$ where $d_1^1 = d^1 +$ radius of steel.

(*7*) $I_s = A_s v^2 + A^1_s t^2 +$ (the moments of inertia of the steel bars about their individual neutral axes, which may be neglected for small rods without appreciable error).

(*8*) $$I_c = \frac{bh^3}{12} - \left(A_s v^2 + A_s^1 t^2 \right)$$

The distribution of the load between the concrete and the steel will be:

(*9*) $$\frac{L_c}{L_s}=\frac{E_cI_c}{E_sI_s}=\frac{I_c}{eI_s}=g$$

(*10*) $$c=\frac{g}{1+g} \text{ and } s=\frac{1}{1+g}$$

(*11*) $$M=\frac{I_sf_s}{zs}$$

(*12*) $$M=\frac{I_sf_s^1}{us}$$

(*13*) $$M=\frac{I_cf_c}{yc}$$

(*14*) $$M=\frac{I_cf_c^1}{xc}$$

If $f_c=0$, that is, if the concrete does not resist tensile stresses—the condition that exists after the concrete has failed in tension, but before the ultimate resistance of the reenforced beam has been reached—we have: (*15*)

$$x=-\frac{e}{b}\left(A_s+A_s^1\right)+\sqrt{\frac{e^2(A_s+A_s^1)^2}{b^2}+\frac{2e}{b}\left[A_s^1d_1^1+A_s(h''+d_1^1)\right]}$$

(*16*) $I_c=\frac{bx^3}{3}$, nearly, if A_s and A_s^1 are small.

(*17*) $I_s=A_sv_2+A_s^1t^2$, nearly.

If $A_s^1=0$, that is if the steel reenforcement is on the tensile side of the neutral axis only,

(*18*) $$x=-\frac{e}{b}A_s+\sqrt{\frac{e^2A_s^2}{b^2}+\frac{2e}{b}A_s(h''+d_1^1)}$$

(*19*) $I_c=\frac{bx^3}{3}$, nearly, if A_s is small.

(*20*) $I_s=A_sv^2$, nearly.

Proceeding now to an examination of some of these formulas in detail, a value for y of (*1*) can be found as follows:

If the rods are small, f_s and f_s^1 may be taken as the intensity of stress throughout the entire section of the rods in tension and compression, respectively.

For equilibrium:

The sum of the compressive stresses = the sum of the tensile stresses, or symbolically,

$$F_c = F_t \qquad (1)$$

Let C_c and C_t equal the compressive and tensile stresses in a concrete beam of the same dimensions as the reenforced beam.

Let S_c and S_t equal the excess of stress in the steel over that in the same area of concrete in the same position in the beam.

Then (*1*) may be expressed

$$C_c + S_c = C_t + S_t \qquad (2)$$

$$\text{Now } C_c = \frac{bxf_c^1}{2} \qquad (3)$$

$$S_c = f_s^1 A_s^1 - \left(\frac{x - d_1^1}{x} f_c^1\right) A_s^1 \qquad (4)$$

$$C_t = \frac{byf_c}{2} \qquad (5)$$

$$S_t = f_s A_s - \left(\frac{y - d_1}{y} f_c\right) A_s \qquad (6)$$

Substituting these values in (*2*)

$$\frac{bxf_c^1}{2} + \left[f_s^1 A_s^1 - \left(\frac{x - d_1^1}{x} f_c^1\right) A_s^1\right] = \frac{byf_c}{2} + \left[f_s A_s - \left(\frac{y - d_1}{y} f_c\right) A_s\right] \qquad (7)$$

Now, since by our assumption the strain in any fiber is proportional to its distance from the neutral axis, and since $\frac{F}{A} = \frac{\lambda E}{l}$, λ A and l remaining the same for either material at a given position in the beam, $\frac{F}{A}$ must vary as E, A representing any area under consideration.

Now for steel in tension $\frac{F}{A} = f_s$

For steel in compression $\frac{F}{A} = f_s^1$

For concrete in tension $\frac{F}{A} = \frac{y-d_1}{y} f_c$

For concrete in compression $\frac{F}{A} = \frac{x-d_1^1}{x} f_c^1$

at those distances from the neutral axis at which the reenforcing rods are placed.

From the foregoing: $\dfrac{f_s^1}{\frac{x-d_1^1}{x} f_c^1} = \dfrac{E_s}{E_c}$

$$\text{or} \quad f_s^1 = \frac{x-d_1^1}{x} f_c^1 e \qquad \text{since} \quad e = \frac{E_s}{E_c}$$

$$\text{Similarly} \quad f_s = \frac{y-d_1}{y} f_c e$$

Substituting these values of f_s^1 and f_s in (*7*) we have:

$$\frac{bxf_c^1}{2} + A_s^1 \left[\frac{x-d_1^1}{x} f_c^1 (e-1)\right] = \frac{byf_c}{2} + A_s \left[\frac{y-d_1}{y} f_c (e-1)\right] \qquad (8)$$

Dividing by f_c^1 and remembering that $\frac{f_c}{f_c^1} = \frac{y}{x}$

$$\frac{bx}{2} + A_s^1 \frac{x-d_1^1}{x}\left(e-1\right) = \frac{by}{2} \cdot \frac{y}{x} + A_s \frac{y-d_1}{y} \cdot \frac{y}{x}\left(e-1\right)$$

Or,

$$\frac{bx^2}{2} + A_{s1}\left(x-d_1^1\right)\left(e-1\right) = \frac{by^2}{2} + A_s\left(y-d_1\right)\left(e-1\right) \qquad (9)$$

Substituting for x, its value h − y

$$b(h-y)^2 + 2A_s^1(h-y-d_1^1)(e-1) = by^2 + 2A_s(y-d_1)(e-1). \qquad (10)$$

Solving this equation for y gives

$$y = \frac{\frac{bh^2}{2} + [A_s d_1 + A_s^1 (h-d_1^1)]\,(e-1)}{A + (A_s + A_s^1)\,(e-1)}$$

which is the correct value of y.

This formula may be deduced very simply in another way from the well-known theorem that, with both stresses and strains proportional to the corresponding distances from the neutral axis, the neutral axis must pass through the center of gravity of a homogeneous section. To bring our non-homogeneous section under this theorem, we must replace the steel by concrete, and also add enough concrete at the same distance from the top and bottom of the beam to take the excess of stress in steel, over that taken by the concrete in its place. (See fig. 2.) The unit stresses in the steel are $f_s^1 = e\frac{x-d_1^1}{x}f_c^1$ and $f_s = e\frac{y-d_1}{y}f_c$. The total stresses taken by the steel are $f_s^1A_s^1 = e\frac{x-d_1^1}{x}f_c^1A_s^1$ and $f_sA_s = e\frac{y-d_1}{y}f_cA_s$.

The unit stresses in the concrete at this same position are

$$\frac{x-d_1^1}{x}f_c^1 \text{ and } \frac{y-d_1}{y}f_c$$

So the stresses taken by the concrete replacing the area of the steel will be

$$\frac{x-d_1^1}{x}f_c^1A_s^1 \text{ and } \frac{y-d_1}{y}f_cA_s$$

Hence, denoting by A_c^1 and A_c the *additional* area of concrete in compression and tension, we have

$$A_c^1 = \frac{e\frac{x-d_1^1}{x}f_c^1A_s^1 - \frac{x-d_1^1}{x}f_c^1A_s^1}{\frac{x-d_1^1}{x}f_c^1} = \left(e-1\right)A_s^1$$

and $A_c = (e-1)A_s$. Taking moments about the bottom of the section, we have, for the position of the center of gravity of this area,

$$y = \frac{\frac{bh^2}{2} + \left(e-1\right)A_s^1\left(h-d_1^1\right) + \left(e-1\right)A_sd_1}{bh + (e-1)A_s^1 + (e-1)A_s}$$

or,

$$y = \frac{\frac{bh^2}{2} + \left[A_sd_1 + A_s^1\left(h^1-d_1^1\right)\right](e-1)}{A + (A_s+A_s^1)(e-1)}$$

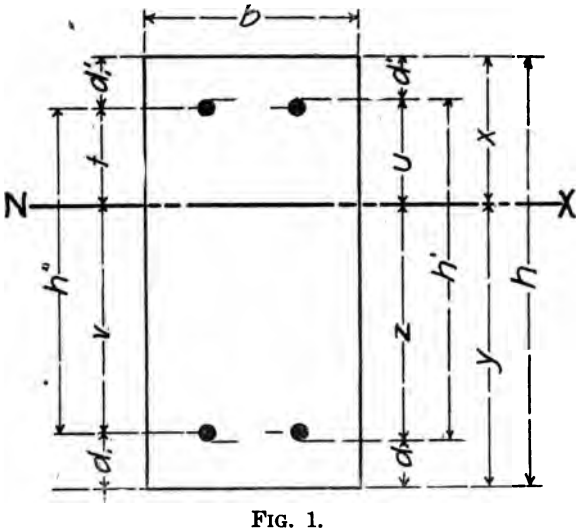

FIG. 1.

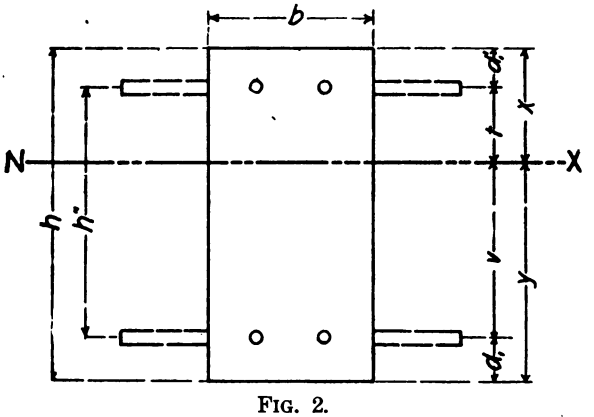

FIG. 2.

Comparing this with the author's formula (*1*), we notice that the terms d_1 and $h^1-d_1^1$ are raised to the second power, and that the sign of addition between the two main terms should be replaced by a sign of division. The latter is a mere misprint, as is evident from an illustrative example worked out on the succeeding page in the book. But the exponent is retained in this same example, showing that it is designed to be there. The numerical significance of the mistake may be shown by an example.

Consider a beam 4 inches wide and 16 inches deep. Let there be a rod 1 inch in diameter, so placed that its center is $1\frac{1}{2}$ inches

from the top of the beam, and a similar rod at the same distance from the bottom. Then $b=4$, $h=16$, $d_1=d_1^1=1\frac{1}{2}$, $A_s=A_s^1=.7854$ sq. in. Assume $E_s=29{,}000{,}000$ and $E_c=2{,}900{,}000$. Then $e=10$. Substituting these values in the author's formula (1), we have:

$$y=\frac{4\times\frac{16^2}{2}+\left[.7854(1.5)^2+.7854(14.5)^2\right]9}{64+(1.5708)9}$$

$=25.8$ inches. Substituting these same values in our new formula, we have

$$y=\frac{4+\frac{16^2}{2}+\left[.7854\times1.5+.7854\times14.5\right]9}{64+(1.5708)\times9}=8''$$

which is the correct result, since our beam was assumed symmetrical. Probably the reason that the author did not discover such an obvious mistake is because he assumed in his numerical example a beam having no reenforcement on the upper side. And it is in the square of the large term $h-d_1^1$ that the greatest error appears. Now, in the case of a built-in beam, reenforcement would be put in the top of the beam for at least part of its length.

The next formula that requires comment is formula (*8*)

$$I_c=\frac{bh^3}{12}-\left(A_sv^2+A_s^1t^2\right)$$

This should be $I_c=\frac{bh^3}{12}+bh\left(\frac{h}{2}-y\right)^2-\left(A_sv^2+A_s^1t^2\right)$

That is, in order to subtract one moment of inertia from another we must have them about the same axis. From the moment of inertia of the entire area about its center of gravity the author subtracts the moment of inertia of the steel about the neutral axis of the beam. This is correct only when these two coincide. And this is not generally the case. The extra term may or may not be a negligible quantity.

If we omit the rod in the upper part of the beam of our preceding example, we have $b=4''$, $h=16''$, $A_s=.7854$ sq. in.

$A_s^1=o$, $d_1=1\frac{1}{2}''$ and $e=10$.

$$y=\frac{\frac{4\times16^2}{2}+\left[.7854\times1.5\times9\right]}{64+.7854\times9}=7.37''$$

$$v=y-d_1=7.37-1.5=5.87''$$

whence, using the author's formula,

$$I_c = \frac{4 \times 16^3}{12} - .7854 \times (5.87)^2 = 1365 - 27 = 1338$$

$$\frac{h}{2} - y = 8 - 7.37 = .63''$$

Our added term is then $bh\left(\frac{h}{2} - y\right)^2 = 64 \times .63^2 = 25$, which shows that the missing term is, in certain cases at least, about as important as the second term of the formula given.

The next formula to which we direct attention is formula (*15*). We will apply the second method used in deducing formula (*1*). Now, however, we shall take moments about the top of the beam instead of the bottom.

A_c^1 = the area to be added to take the excess of stress in steel in compression $= (e-1)A_s^1$.

A_c = the area to be added to replace the steel in tension $= eA_s$.

$$eA_s + \left(h'' + d_1^1\right) + \left(e-1\right)A_s^1 d_1^1 + \frac{bx^2}{2} = x\left[eA_s + \left(e-1\right)A_s^1 + bx\right]$$

$$x^2 + \frac{2[eA_s + (e-1)A_s^1]x}{b} = \frac{2eA_s(h'' + d_1^1) + 2(e-1)A_s^1 d_1^1}{b}$$

whence

$$x = -\frac{e(A_s + A_s^1) - A_s^1}{b}$$

$$+\sqrt{\frac{[e(A_s + A_s^1) - A_s^1]^2}{b^2} + \frac{2e[A_s(h'' + d_1^1) + A_s^1 d_1^1] - 2A_s^1 d_1^1}{b}}$$

The difference here is not large unless A_s^1 is large. And generally if the concrete did not take tension, all the reenforcing would be on the lower or tensile side of the beam. But in formula (*1*) the author multiplies his areas by $(e-1)$; so, to be consistent, he should do the same here for the area in compression.

We have not discovered any further errors in this set of formulas. There is, however, an important error in their application to which we wish to call attention. The author uses this example:

"What is the safe bending moment for a reenforced concrete beam 16 inches deep, 4 inches wide, having one steel rod $\frac{7}{8}$ inch in diameter on the tensile side only, so placed that the center of

the rod is $1\frac{1}{2}$ inches above the bottom of the concrete? The resistance of concrete to tensile stresses is neglected. $f_c^1=700$, $E_c=3{,}600{,}000$, $E_s=29{,}000{,}000$."

Following is the author's solution of the problem:

"From equation (*18*) we have

$$x=-\frac{8.06}{4.0}\times 0.6+\sqrt{\frac{64.89\times 0.36}{16}+\frac{16.11}{4}0.6\times 14.5}$$
$$=-1.209+\sqrt{1.46+35.04}=4.833''$$

"From equation (*19*) we get

$$I_c=\frac{4\times 112.89}{3}=150.52$$

and from equation (*20*)

$$I_s=93.45\times 0.6=56.07.$$

"Since all the tensile stresses are carried by the steel, and all the compressive stresses by the concrete, and since the tensile stresses must balance the compressive stresses to fulfil the conditions of stability, we have $c=s=0.5$, and from equation (*14*) we obtain

$$M=\frac{150.52\times 700}{4.833\times 0.5}=43{,}601.9 \text{ inch-pounds.}"$$

This solution is correct up to the words, "we have $c=s=0.5$."

This conclusion does not in general follow from the statement preceding it. It will follow when $v=\frac{2}{3}x$, and only then; for, if the stresses in tension and compression are equal, their lever arms must be equal in order to produce equal moments. The tensile stress is evidently applied at a distance of v from the neutral axis. The compressive stress increases from 0 at the neutral axis to f_c^1 at a distance x from the axis. So its point of application must be at a distance of $\frac{2}{3}x$ from the neutral axis. This condition does not obtain in this case.

Further, we should obtain the same moment from the use of equation (*11*) as from equation (*14*).

To use equation (*11*) we must compute f_s and z (=v approximately)

$$v = h - x - d_1 = 16 - 4.833 - 1.5 = 9.667''$$

$$f_s = e\frac{v}{x}f_c^1 = 8.06 \times \frac{9.667}{4.833} \times 700 = 11{,}284.$$

Substituting these values, and s=0.5 in formula (*11*) we have

$$M = \frac{56.07 \times 11284}{9.667 \times 0.5} = 130{,}875 \text{ inch-pounds.}$$

The correct solution is as follows:

From (*9*) $g = \frac{I_c}{eI_s} = \frac{150.52}{8.06 \times 56.07} = .333.$

From (*10*) $c = \frac{g}{1 \times g} = \frac{.333}{1.333} = 0.25$ and $s = \frac{1}{1.333} = 0.75.$

Substituting these values in (*14*) and (*11*), respectively, we get from (*14*): $M = \frac{150.52 \times 700}{4.833 \times .25} = 87{,}203.$

From (*11*), $\frac{56.07 \times 11284}{9.667 \times .75} = 87{,}250;$

which are the same, except for the slight difference due to decimals.

EXAMINATION OF COAL-DUST AFTER EXPLOSIONS IN MINES OF SOUTHEASTERN KANSAS.

By EDWARD BARTOW, University of Illinois, Urbana, Ill., read before the Academy December 1, 1905.

WHILE investigating the effects of coal-mine explosions in the mines of southeastern Kansas, in February, 1905, I collected two specimens of coal-dust showing the effect of the heat of the explosion. This coal-dust was on the sides of the timbers towards the explosion, and evidently had been carried through the air by the force of the explosion. The intense heat had apparently partially melted the particles of dust, causing them to stick together and to adhere to the supports and to the sides of the mines near the spot where the explosion originated. The coating of dust was at least one-quarter of an inch thick. In this paper are shown comparative analyses of this dust and of the coal collected from the respective mines, in an endeavor to show the effect of intense heat of the explosion on the coal.

Specimen of dust No. 1*a* was taken from the J. H. Bennett Coal Company's mine No. 1, two and one half-miles northwest of Weir City. In this mine an explosion occured January 26, 1905. Two shot-firers lost their lives and the interior of the mine and the shaft were considerably damaged.

Specimen of dust No. 2*a* was collected on February 24 from mine No. 1 of the Devlin & Miller Coal Company's mines, near Frontenac, six miles north of Pittsburg, Kan. In this mine two explosions occurred, on February 1 and 9, 1905, in which two shot-firers lost their lives. The interior workings of the mine were badly damaged, but, owing to the greater development, the explosion spent itself before reaching the shaft.

Specimen of coal No. 1 was collected from the J. H. Bennett Coal Company's mine No. 1 by Mr. James A. Orr, state mine inspector of Kansas. Specimen of coal No. 2 was taken by the writer from the Devlin & Miller Coal Company's mine No. 1, from the room in which the explosion of February 9 is supposed to have originated.

In the specimens of coal and dust thus obtained determinations of moisture, volatile and combustible matter, fixed carbon and ash are made according to the methods described in volume III of the University Geological Survey of Kansas, page 272.

For the sake of comparison of methods, we have added the results of a few analyses of Kansas coals from neighboring mines, made by Dr. W. R. Crane, and recorded on page 278 of volume III of the University Geological Survey of Kansas.

No.	NAME.	Moisture.	Volatile and combustible.	Fixed carbon.	Ash.
1	J. H. Bennett Coal Company No. 1, coal	1.84%	40.55%	50.25%	7.36%
1*a*	J. H. Bennett Coal Company No. 1, dust	1.45	28.12	51.03	19.40
	Coal from neighboring mines, Weir City, Kan.:				
8	Kansas & Texas No. 18	3.57	36.96	51.84	7.63
9	Kansas & Texas No. 47	3.16	39.21	53.87	3.76
10	Durkee Coal Company No. 4	2.34	36.88	55.69	5.09
12	Hamilton & Braidwood No. 2	2.63	38.80	53.74	4.83
13	Central Coal Company No. 5	3.14	34.87	55.39	6.60
14	Durkee Coal Company No. 1	2.57	36.34	54.99	6.10
15	The Excelsior Coal Company	2.58	36.73	55.02	5.62
	Average of seven	2.857%	37.11%	54.70%	5.88%
2	Devlin & Miller mine No. 1, coal	1.79	39.13	53.41	5.67
2*a*	Devlin & Miller mine No. 1, dust	1.20	31.23	54.22	13.35
	Coal from a neighboring mine, Frontenac, Kan.	3.06	35.92	54.89	6.13

In the results of our examination we would call attention especially to the decrease in the volatile and combustible matter and the increase in fixed carbon and ash.

The dust after the explosion is probably mingled with dust from the roof and floor of the mine or it would be the best index of the amount of coal consumed by the explosion. In the one case the ash increased 2.35 times, and in the other 2.54. While this comparison is not accurate, it would indicate that a considerable proportion of the finely divided carbon was oxidized in the explosion.

The decrease in the volatile and combustible material is also interesting, and we would mention the fact that the finely divided coal is browner in color than the finely divided dust, and, also, when placed on white paper, leaves a much more decided streak. Experiments with regard to the action of air on the finely divided dust are being carried on.

THE FOUCAULT EXPERIMENT.

By J. T. LOVEWELL, Topeka.

AMONG the scientific achievements of the French philosopher, Foucault, there is none that made him so widely known as the pendulum experiment, whereby he rendered visible the rotation of the earth. This experiment was published in 1851 and was at once repeated by many scientific men in Europe and America. Arago performed it at the University of Paris, and it was exhibited in the Pantheon, with a pendulum 220 feet long.

In our own country it was set up in Bunker Hill monument, in the capitol, at Washington, and in various state capitols.

Use was made of these lofty edifices, which had requisite solidity, and allowed a longer pendulum than can often be installed in smaller structures. While long pendulums are desirable in this experiment, they are by no means essential to show the main fact of the rotation of the earth. Foucault's original experiment was made with a pendulum only six and one-half feet long, and with this he demonstrated the earth's rotation with entire success.

The idea of Foucault's pendulum is involved in the law of inertia, and it had occurred to others long before his time, but he was the first to bring it to a demonstration. The vibration is caused by force of gravity, always directed toward the center of the earth, and is entirely independent of the motion of the point of suspension. The absolute motion of the pendulum in space is very complicated, and involves both the annual and diurnal rotations of the earth, but we are here concerned only with the relative change in direction, with lines on the earth, and this is, as we shall see, at the poles, fifteen degrees per hour. By considering the pendulum mounted on a prolongation of the earth's axis, its plane of oscillation will cut across the meridians and will make a complete circuit in twenty-four hours.

At the north pole this apparent rotation would be like the hands of a watch, from left to right, while at the south pole this motion would appear in the contrary direction. At the equator there would be no rotation, while in other latitudes the motion would be the rate at the poles multiplied by the sine of the latitude. This may be shown in various ways by mathematical demonstration, and may be simply illustrated by the use of a globe, and drawing a line in the plane of oscillation, and comparing its direction with

various meridians. The globe will show the apparent revolution of the plane of inertia, and the time will be twenty-four hours divided by sine of latitude.

The first attempt by the author of this paper to make an accurate Foucault pendulum was at Washburn College, some six or seven years ago, where one of the ventilating shafts in what is now called Rice hall was used, and where one could get a length of more than fifty feet, but the arc of vibration could be not more than one and one-half feet. The greatest difficulty was the narrow space for making adjustments, and yet some results were shown to this Academy which appeared to be of interest. The plan was adopted of marking the oscillations with a needle on a plate of smoked glass, and then blue-prints were made of these pendulum markings for the first time in experiments with the Foucault pendulum. One of these prints, made six or seven years ago, is still preserved.

In the state-house, near the Academy rooms, is a space which seems peculiarly well suited to the Foucault experiment. It is in one of the light shafts, and the Executive Council were ready to grant the use of this waste space for these experiments, provided no expense to the state was incurred. The light shaft in question is a space of about ten by fifteen feet, and extends from the first floor to the roof, where it is surmounted by a skylight resting on a system of iron trusses and rafters, and the rafters are covered with sheets of plate roofing glass.

The pendulum wire passes through a hole drilled through this glass, and then through a steel plate by a hole just large enough to admit a No. 15 piano wire. The wire is wound on an iron cylinder an inch in diameter, with a crank and a rachet wheel, furnished with a dog to hold it in any desired position. The length of this pendulum as determined by its rate of oscillation is about seventy-three feet, and the bob is a cylinder of lead terminating with a cone at the bottom, and weighs sixty-eight pounds. The lead is cast around a stout brass tube and is turned on a lathe to a symmetrical form. The brass tube coming through the lower extremity of the bob has inserted in it three concentric glass tubes, the inner one being just large enough to admit easily a No. 1 sewing needle. This smaller tube is narrowed by heating until it is able to let the point of the needle pass through one-fourth of an inch. It is now free to play up and down through this distance, and to trace on the smoked glass below the course of the pendulum through its circular arc. The time of a double oscillation is very close to three and one-half seconds. To start the pendulum, it is pulled to one

side by a small cord attached to a staple fixed as near as could be estimated to its center of oscillation. The thread is fastened to the wall and the bob, thus displaced, is left until it comes entirely to rest. Then the string is burned off and without any lateral push the pendulum falls, simply under the impulse of gravity. The smoked-glass plate rests on a platform, which has a mechanism for raising and lowering with parallel motion, and permits the tracing needle to follow the plate two or three feet or any other desired distance.

There are several disturbing agencies which prevent the pendulum from tracing a straight line as it swings, and make it move in an ellipse of greater or lesser eccentricity. The most troublesome of these is the action of air currents, which cannot be wholly avoided. Even if the room were tightly closed, the variations of temperature and movements of the observer would cause fluctuations of air which would sensibly affect the pendulum.

Another difficulty is the elasticity of the suspending wire. This is bought in coils and it is difficult so to straigthen it that it will not tend to fall in spiral twists which are not equally elastic in every direction. Then there is lack of perfect rigidity in the point of suspension, which must also fail to represent a true mathematical point. There is no better plan for suspension yet devised than the method described above, of allowing the wire to pass tightly through a hole in a metal plate.

The author once thought it important to provide a plan for rotation of the wire, but became convinced that this refinement was entirely useless. Aside from these mechanical imperfections there is another and an insurmountable object, which prevents the pendulum from swinging backward and forward in the same path. When the pendulum is drawn aside at its starting it must partake of the rotary motion of the earth, and this, combined with the gravitational force, is sure to give it an elliptical course. In securing the graphical representation of these vibrations, there is still another disturbing element, for our needle-point can seldom be brought into the true axis of the pendulum. Where this needle-point is not in the true axis its friction against the smoked glass tends to give the bob a rotary oscillation, and, in the experiments hitherto made, this rotary oscillation is quite in evidence. It gives the outside edge of our blue-print a curious wavy border, and the time of these oscillations is many fold greater than the regular swings of the pendulum. The impelling force is here the torsional elasticity of the wire, which, acting on the heavy weight, gives a

true harmonic motion, and the slowest hitherto observed by the author of this paper. It would require a pendulum many hundred feet long to secure this rate of vibration. There is still another oscillatory movement to be observed in our pendulum, and this is a vertical oscillation, an up-and-down movement, due to the longitudinal elasticity of the wire. This movement is much more frequent than the former and has no influence on the Foucault experiment.

It will be seen from inspection of the graphs that the minor axis of the elliptical oscillation is very small, not more than one-tenth of an inch in a swing of four feet, and the air currents are probably responsible for most of this. The time is so recent since the installation of the apparatus that but few experiments have as yet been made, but they encourage us to expect results as good as any hitherto obtained by other observers.

There is a thought, too, that this pendulum may record seismic motions, which will certainly be of interest.

The pendulum is where any visitor to the state-house can see it, and there is a certain impressiveness in the sweep of the heavy weight to and fro so steadily. When starting with long vibrations, and watched for some time, close observers will notice that the period of oscillation is sensibly shorter as the arc becomes less. The old Florentine, Galileo, was mistaken in thinking the swinging chandelier performed its vibrations in equal times, whether through long or short swings, but he was near enough right to instal the pendulum as our most perfect measurer of time. Starting with an arc of ten feet, this pendulum will continue to swing as much as fourteen hours when it does no work in tracing the smoked glass. After a few hours its path cuts across its first direction with an angle that shows the time of a complete rotation at this latitude to be more than forty hours. The cuts herewith given exhibit the deviation at different intervals, but experiment has not been made sufficiently as yet to secure accurate numerical results. These may be given in a future paper.

It was intended to exhibit the tracings of this pendulum by half-tone engravings taken from the smoked-glass blue-prints, but they will not do for making printing plates, and time has not been allowed for securing them in other ways. For the finest results these experiments must be made when the air is still, because the wind gives a tremulous motion to the state-house roof which disturbs the pendulum.

A DEEP WELL AT EMPORIA.

By Alva J. Smith.

THE well under consideration was drilled by Roberds & Lane for the city of Emporia, which had provided funds for the purpose by the issuance of development bonds. The well was begun soon after the first of the year 1904, the contract calling for a depth of 2000 feet, or to the Mississippian limestone. In the prosecution of the work the contractors were very unfortunate, having to abandon two wells at their own expense.

The first well was lost on account of the drill stem breaking, leaving the bit in the well at a depth of about 700 feet, where it was never recovered, although several weeks were spent in fishing for it. In the other well, which was drilled twelve feet south of the first one, a lug of iron was encountered. After drilling out large quantities of iron, the well was shot three different times, in the hope that the obstruction would be dislodged, but it continued to cut the rope, injure their tools, and impede the drilling, till the well was abandoned at a depth of 890 feet. In this well a stratum of coal of considerable thickness was encountered at a depth of 714 feet. As there was a probability of this coal being of commercial value, preparations were made for more accurately determining its thickness in the third well, which was drilled thirty feet south of the second one.

Eight or ten oil barrels were secured for the reception of all the drillings to be taken from the well while passing through or near the coal, and a contract was made with the drillers requiring them to remove their tools, bail out and measure up the well with a steel tape as often as the city might require.

The same formations were penetrated in this well as the other two, and the ten-inch casing put down to a depth of 690 feet, and no water was encountered for the next fifty feet.

When the hard sandstone above the coal was reached, the special gas committee of the city council and I were notified, and the work from that time till the coal was passed was under our personal supervision. When the drill penetrated a soft stratum beneath the sandstone they bailed out, and found they were drilling in slate. The depth of the well was then taken with a steel tape and the drillers instructed to drill one foot and then bail out, which they attempted to do, but the spring of the rope let the drill down

through the soft material four feet. On removing the drill it was found covered with coal and the water taken from the well was black. All the material removed by the bailer was saved and washed out. The drillings from this run proved to be one-fourth coal and three-fourths slate and bituminous shale. They then made a run of one foot all in coal. The next run was four inches in depth, and there was a trace of fire-clay on the point of the bit when removed, indicating that it had reached the bottom of the coal.

The next run of six inches was made in fire-clay, the drillings being about one-half coal, which was carried down from above, as the bailer is so constructed that it does not remove all the drillings, but leaves about a foot of them in the bottom each time, which would necessarily be mixed with the drillings of the succeeding run.

The thickness of the coal as thus shown was twenty-eight inches.

Another estimate of the thickness of the coal was made in the following manner:

From the	4-foot run	665	cubic inches of coal	was saved.	
"	1-foot run	960	"	"	"
"	4-inch run	288	"	"	"
"	6-inch run	265	"	"	"
Total		2,178			

Dividing the total number of cubic inches saved by 960, the number of cubic inches saved from the one-foot run in pure coal, we have 2.27 feet, or 27¼ inches, as the total thickness of the coal.

An analysis of the coal yielded the following quantities:

Water	7.96	per cent.
Volatile matter	33.13	"
Fixed carbon	39.64	"
Ash	17.27	"
Total	100.00	per cent.

The coal cokes readily and leaves a reddish-brown ash.

A sample was sent to Prof. E. H. S. Bailey, of the University of Kansas, and the following report was received from him:

"Moisture	7.91	per cent.
Volatile and combustible matter	35.38	"
Fixed carbon	38.08	"
Ash	18.63	"
Total	100.00	per cent.

"The coal leaves a red ash and cokes quite readily. By comparing it with other Kansas coals which are mentioned in volume III of the Kansas Geological Survey, it is evident that in some characteristics this coal is like the Osage; others like one sample of Lansing coal analyzed. The chief objection to the coal is the high percentage of ash. E. H. S. BAILEY."

A number of fine, sharp sands, resembling oil and gas sands, were found, but all contained salt water, instead of the hydrocarbons sought.

The figures in the column at the left of the accompanying well section are the numbers of the consecutive strata from the top downward; those in the first column to the right show the thickness of the strata, and those in the second column to the right give the depth in hundreds of feet from the top downward.

The well is located on lot No. 50 Congress street, in the city of Emporia, at a surface elevation of 1130 feet above sea-level.

Samples of the drillings were taken for the city by William Campbell and placed in their regular order in glass tubes, which are now on exhibition in the museum of the Kansas State Normal School.

Careful laboratory tests of the samples were made to see that they were properly named, and from the results I am convinced that the apparant discrepancies in the logs of wells from the same locality are largely due to the inaccurate naming of the samples, as well as lack of care on the part of the drillers to observe and report changes that occur in the formation.

On comparison with the samples taken from the Madison well* I find it quite easy to correlate a great many of them by their lithological character. The two sections agree very closely down to the bottom of the Iola limestone, where, instead of the ninety-nine feet of shale found at Madison, we have but seventeen feet at Emporia, which practically throws the Garnett, Iola and Erie or Bronson limestones into one great series of limestone beds extending from the Lawrence to the Pleasanton shales, a depth of 400 feet.

The Cherokee shales have a thickness of 356 feet, and the proportion of sand encountered is not greatly different from that in the Madison well.

Good samples of the Mississippian were secured which prove that that formation retains its flinty character westward at least as far as Emporia.

A careful comparison of the reliable logs and the samples from the various deep wells in Kansas would be an interesting study that I doubt not would result in valuable information in regard to the character, thickness and extent of the various formations, and perhaps throw some additional light on the geological history of our state.

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* See Trans. Kan. Acad. Sci., vol. XVI, p. 67.

LOG OF A DEEP WELL AT EMPORIA, KAN.

No.	Strata.	Thickness.	Depth.
1	Soil	3 feet.	3 feet.
2	Clay, light	22 "	25 "
3	Gravel; fresh water	5 "	30 "
4	Limestone, blue	2 "	32 "
5	Shale	4 "	36 "
6	Limestone, blue	3 "	39 "
7	Shale	14 "	53 "
8	Limestone	7 "	60 "
9	Soapstone	12 "	72 "
10	Limestone	13 "	85 "
11	Limestone, red, shaly	9 "	94 "
12	Limestone	4 "	98 "
13	Shale, blue	42 "	140 "
14	Limestone	5 "	145 "
15	Shale	16 "	161 "
16	Limestone	2 "	163 "
17	Sand	10 "	173 "
18	Shale	2 "	175 "
19	Sand, micaceous	15 "	190 "
20	Sandy shale, brown	67 "	257 "
21	Limestone and black shale	7 "	264 "
22	Coal	½ "	264½ "
23	Fire-clay	½ "	265 "
24	Shale, sandy	26 "	291 "
25	Sandstone	10 "	301 "
26	Sandy shale; dark salt water	39 "	340 "
27	Limestone, green streaks	25 "	365 "
28	Shale	16 "	381 "
29	Limestone	8 "	389 "
30	Shale, brown	30 "	419 "
31	Limestone; dark fossils	7 "	426 "
32	Shale, black, bituminous	5 "	431 "
33	Limestone, white	4 "	435 "
34	Shale	5 "	440 "
35	Limestone; *Fusulina*	10 "	450 "
36	Shale, green	17 "	467 "
37	Limestone, fossils, red in places	5 "	472 "
38	Shale, dark steatite	20 "	492 "
39	Limestone, blue	15 "	507 "
40	Shale	8 "	515 "
41	Limestone	15 "	530 "
42	Shale, steatite	16 "	546 "
43	Limestone	4 "	550 "
44	Shale, calcareous	6 "	556 "
45	Sand	5 "	561 "
46	Shale, sandy	10 "	571 "
47	Limestone, fossiliferous	4 "	575 "
48	Shale, dark, calcareous	4 "	579 "
49	Sand	22 "	601 "
50	Shale, blue	14 "	615 "
51	Limestone, with calcite crystals	41 "	656 "
52	Shale, black	6 "	662 "
53	Limestone, soft, white	9 "	671 "
54	Shale, slaty	18½ "	689½ "
54½	Coal	½ "	690 "
55	Sand, hard	19 "	709 "
56	Shale, slate	3 "	712 "
57	Coal	2 "	714 "
58	Fire-clay	1 "	715 "
59	Sand	20 "	735 "
60	Shale, sandy	65 "	800 "
61	Limestone, blue	5 "	805 "
62	Shale, sandy	15 "	820 "
63	Sand, and dark brown, lime fossils	13 "	833 "
64	Shale	9 "	842 "
65	Sand	64 "	906 "
66	Sandy shale	38 "	944 "
67	Limestone, white, crystallized	6 "	950 "
68	Sand	18 "	968 "
69	Lime, white, soft, granular	17 "	985 "
70	Lime, white, hard, calcite crystals	8 "	993 "
71	Slate; salt water	5 "	998 "
72	Limestone	19 "	1,017 "
73	Shale, soapstone	6 "	1,023 "
74	Limestone, white	31 "	1,054 "
75	Shale, soapstone	10 "	1,064 "
76	Limestone; fossils, undetermined	40 "	1,104 "
77	Shale, argillaceous	3 "	1,107 "

LOG OF A DEEP WELL AT EMPORIA, KAN.—CONCLUDED.

No.	Strata.	Thickness.	Depth.
78	Limestone, white, crystallized	18 feet.	1,125 feet.
79	Limestone, bluish, hard	64 "	1,189 "
80	Limestone, white	19 "	1,208 "
81	Shale, slaty	17 "	1,225 "
82	Limestone, white	5 "	1,230 "
83	Shale, green streaks	8 "	1,238 "
84	Shale, red, hard	3 "	1,241 "
85	Shale brown	5 "	1,246 "
86	Limestone, fossils	16 "	1,262 "
87	Shale, black, slaty	3 "	1,265 "
88	Limestone, brown and white	45 "	1,310 "
89	Shale, black, bituminous	4 "	1,314 "
90	Limestone, pinkish oolite; salt water	35 "	1,349 "
91	Slate, black, bituminous	5 "	1,354 "
92	Limestone, hard	3 "	1,357 "
93	Shale	2 "	1,359 "
94	Lime	17 "	1,376 "
95	Shale	11 "	1,387 "
96	Sand	33 "	1,420 "
97	Shale, argillaceous	4 "	1,424 "
98	Sand	26 "	1,450 "
99	Shale, red	16 "	1,466 "
100	Shale, green streaks	22 "	1,488 "
101	Limestone, gray; fossils, flinty	16 "	1,504 "
102	Sand, gray	3 "	1,507 "
103	Shale, green	18 "	1,525 "
104	Lime, dark	11 "	1,536 "
105	Shale, black	4 "	1,540 "
106	Sandy shale	20 "	1,560 "
107	Limestone	15 "	1,575 "
108	Shale, slaty	4 "	1,579 "
109	Limestone, brown	16 "	1,595 "
110	Shale, black, bituminous	19 "	1,614 "
111	Shale, light	10 "	1,624 "
112	Shale, brown	3 "	1,627 "
113	Limestone, dark	5 "	1,632 "
114	Shale, slaty	12 "	1,644 "
115	Sand	26 "	1,670 "
116	Shale, brown	11 "	1,681 "
117	Sandy shale, dark	14 "	1,695 "
118	Shale, slaty	20 "	1,715 "
119	Shale, sandy, calcareous, hard	5 "	1,720 "
120	Shale, dark brown, sandy	33 "	1,753 "
121	Sand	5 "	1,758 "
122	Shale, black; bituminous coal	4 "	1,762 "
123	Sandy shale	7 "	1,769 "
124	Shale	16 "	1,785 "
125	Sand	5 "	1,790 "
126	Shale	15 "	1,805 "
127	Limestone, hard, dark	1 "	1,806 "
128	Shale	12 "	1,818 "
129	Limestone	3 "	1,821 "
130	Shale, black, slaty	6 "	1,827 "
131	Shale, dark gray, sandy	121 "	1,948 "
132	Shale, soapstone	3 "	1,951 "
133	Limestone, flinty, Mississippian	.....	.....

THE INTERPRETATION OF INDICATOR DIAGRAMS.

By CHARLES I. CORP, Lawrence.

THE important and essential knowledge to be derived from a careful investigation and study of indicator diagrams is invaluable to the engineer, as they enable him easily to ascertain and establish various facts concerning the use of steam that by any other method would prove complicated and unsatisfactory, of which the following may be stated:

First. It shows whether the valves of an engine are correctly and evenly timed, and also serves as a guide in all necessary adjustments of the same that may be required, in order to insure the best distribution of the steam working within the cylinder, and thereby securing the maximum economy and efficiency of the engine.

Second. The indicator power developed in the cylinder of an engine may be determined; also the quantity of energy lost in various ways; such as leakage of valves, back pressure, too early release, and incorrect adjustment of valves.

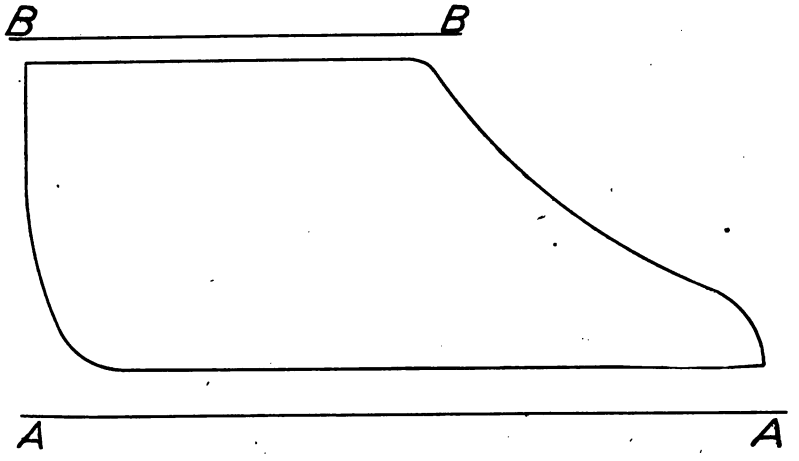
Third. It indicates whether the steam-ports and passages are adequate in size, and a diagram taken from the steam-chest will also show whether the steam-pipe and its connections are of sufficient size.

Fourth. It indicates the condition of the valves and piston in reference to the leakage.

Fifth. In connection with a feed-water test (showing the actual amount of steam consumed), the economy with which the engine works may be determined.

To ascertain with accuracy each and every item of information mentioned above, it is absolutely essential that the diagram should truly represent the position of the piston, and also the pressure exerted on both sides of it, at every point of its stroke.

The general features of a diagram that indicate a proper distribution of the steam in an engine cylinder is represented by diagram, the attainment of which (as near as possible) should be the endeavor of an engineer in setting the valves of his engine. AA is the atmospheric line and BB represents the boiler pressure.



In this diagram the initial steam pressnre, which is the highest pressure realized in the cylinder, is fully maintained up to the commencement of cut-off; indicating ample size of steam-pipes, ports and other passages in the engine.

The expansion curve is good, and the release of the steam is sufficiently early to secure a free exhaust, also low and uniform back pressure.

The exhaust valve closes on the return stroke, in time to provide the necessary compression (or cushion), and thereby counteracting in part the effects of inertia and momentum of the piston, cross-head, and other reciprocating parts, at the end of the stroke.

The admission of steam takes place promptly, and projects the admission line to initial pressure at right angles (or perpendicular) to the atmosphere line. These qualities in a diagram are an especial requisite under any circumstances, to insure an economical working engine.

In practice, however, there will be a great difference in the outline and appearance of the cards from the different engines, and even from the same engine, arising from numerous circumstances and conditions connected with it.

The diagram, as before stated, simply shows the pressure of steam existing in the cylinder at each part of the revolution of the engine, and it is the province of the engineer to determine whether these pressures at each and every point are the correct ones, and, if such is not the case, to ascertain wherein the fault lies that causes the error; then determine upon and apply the remedy.

It must be understood that, in a great majority of cases, the

shape or outline of the diagram depends principally upon the manner in which the steam is admitted to and released from the engine cylinder.

Therefore, by careful investigation and measurement of these outlines, and turning the varied information which they furnish to practical advantage, the real value of the indicator is readily made apparent.

As a preliminary to the study of the diagram, suppose we knew that, at a certain part of the stroke, the full boiler pressure should be realized; now, if this does not appear to be the case on the diagram, there is evidently imperfections existing, either from an incorrect adjustment of the valves, or maybe due to inadequate capacity of the steam-pipes and passages between the boiler and the engine cylinder; and almost invariably happens also with engines having insufficient or extremely light loads.

Again, the diagram may show too great a pressure at other certain points, when we know there should be less, in order that the demands for economy and efficiency in the engine be obtained. This latter circumstance may also proceed partly from incorrect valve adjustment, although it is principally caused by leakage through the admission valves after cut-off; in combination with the revaporation of steam previously condensed within the cylinder in the early part of the stroke.

Any derangement of valve mechanism of the engine, such as incorrect position of the eccentric on the shaft, or an uneven adjustment in the length of the valve-rods in connections, will in consequence be revealed in the diagram by late admission or release, by low initial or high back pressure, also by absence of compression; either of which, in performing an equal amount of work, will result in an increased consumption of steam.

Consequently, where discrepancies of any kind occur, a thorough investigation, study and reasoning of the diagram first become necessary, in order intelligently to locate the cause of the defect, and make changes and corrections accordingly, until the diagram shows a proper distribution of steam pressure throughout the stroke of the engine.

In this paper we shall deal only with the interpretation of irregularities in the lines of the card itself, and what these irregularities indicate.

An indicator diagram is the result of two movements which are at right angles to each other, one of which is the rotation of the paper drum forward and back around its central stud, and is pro-

duced on a reduced scale coincident with and by the movement of the engine cross-head, and thereby tracing a horizontal line on the paper drum at any time a contact is made between the drum and pencil. The other is the vertical movement of the pencil parallel to the axis of the drum, and is produced by the steam pressure acting on the piston of the indicator and forcing it to a height proportionate to the pressure upon the piston. Consequently, the length of the diagram represents the stroke of the engine on a reduced scale, while the vertical height at any point represents the pressure upon the indicator piston at a corresponding point in the stroke of the engine.

We will first study some distortions of the card from the ideal form due to faults of the indicator or its connections.

Should the reducing mechanism used not produce the exact piston motion reduced, or have lost motion in any of its parts, the card will not give a true record of what takes place. This might easily mislead one regarding what actually took place; so that it is essential our reducing mechanism be an accurate one and in good order.

If the steam passages from the cylinder to the indicator are not ample the card will be reduced in height, the initial pressures falling further than we would expect below the boiler pressure. A diagram taken from the steam-chest, will usually locate this trouble.

Waves in a line of the card are caused by the inertia of the indicator parts when the pressure on its piston is suddenly changed. These waves become more marked as the speed of the engine increases, and at high speed cause the card to be much distorted. The distortion from this cause is also increased when the indicator spring used is too weak for the pressure. A spring should be used which will reduce this effect as much as possible without causing the card to be too low to indicate accurately engine faults.

The lines indicating rising or falling pressure will sometimes have steps in them. This is caused by the indicator mechanism sticking, usually by the piston becoming gummed up and sticking in its drum or cylinder.

A wave in a line of the card sometimes appears where we would not expect it from the indicator's inertia or other expected deforming forces, and this can usually be traced to the cord leading from the reducing mechanism rubbing or striking against some object.

The card from extremity to extremity should be as long as the atmospheric line, any difference in this respect showing unequal tension of the cord. Unequal pressure of the pencil against the

paper or stretching of the cord may cause this. The pencil should be well sharpened and held lightly against the drum, and fire wire substituted for long lengths of cord to remedy this. A good braided cord should be used, as they do not stretch as much as others.

The deviations of the cord from the perfect card explained so far have been due to faults in the mechanism for taking the card. We will now take up some departures that indicate faults in the engine itself, beginning with the admission line and going around the card in the order in which the events occur.

The admission line for a properly designed and regulated engine should start from a point one-third to two-thirds the distance up from the bottom or back-pressure line of the card and rise perpendicularly to nearly the boiler-pressure line. It is probably better with some types of engines if this line slopes out a little. Should the line slope too much outwardly, it indicates that this event is too early, and steam is therefore being admitted too much before the end of the stroke has been reached, and will be working against the steam in the other end of the cylinder. If the line, on the other hand, slopes inward from the perpendicular the valve is not opening soon enough, and the piston has started on its return stroke before the steam is admitted. If the admission line rises to the proper height and falls below a horizontal position before reaching cut-off, the passages leading from the boiler to the engine are insufficient at some point. Either the pipe-line or the engine-ports or steam passages do not admit enough steam. A diagram taken from the steam-chest will show whether the trouble lies in the steam line or the engine.

If in the steam line, the steam-chest pressure will drop as the piston travels outwardly on its stroke. At cut-off the line should round with a short bend into the expansion line; failure to do this shows too slow a closing of the valve at cut-off or a leaky valve. If a leaky valve is the cause, it can be told by the expansion curve.

In an unjacketed cylinder, we would expect the expansion line of the steam to be adiabatic. In the actual engine, however (jacketed usually with some non-contracting material), where the cylinder walls furnish some heat during the expansion and entrained and condensed water is evaporated during the latter part of expansion, the line is found to approach very near to the isothermal expansion curve. By drawing this curve in, then, we can determine whether the expansion took place as it should. An expansion curve which is too high shows that steam entered the cylinder after cut-off, and that the valve must leak. A leaky valve

will be less noticeable in the earlier part of expansion because the difference in pressure is slight, but will become more and more apparent on the expansion line as the pressure becomes more unbalanced in the latter part of the stroke. The presence of entrained moisture will also cause the terminal pressure to be high to some extent.

A leaky piston or exhaust valve, on the other hand, will give too low an expansion curve.

When release occurs too early the expansion line will drop suddenly before the end of the stroke is reached, to the back-pressure line, or very near it. Too late a release will cause the back pressure to be high at the beginning of the return stroke. A slow-opening exhaust valve will tend to slope the back-pressure line from release.

Cramped exhaust openings will raise the back-pressure line, which should not be at a height equal to more than two or three pounds above the atmospheric line. Compression should begin at a point that will bring the pressure in the cylinder up to one-third to two-thirds the distance to the top of the card when admission takes place. If less than this, the compression will not overcome the inertia of the reciprocating parts. If the line rises too high, compression takes place too early, and power is lost.

A BIT OF ENGINEERING AT MOUNT VERNON.

By M. L. WARD, Ottawa University.

THE mansion at Mount Vernon is about one-fourth of a mile from the Potomac river and about 150 feet above it. For about 400 yards from the river towards the mansion there is a wooded slope, crowned by a precipitous bluff from ten to fifteen feet in height. This bluff is about 100 yards from the mansion. This slope extending along the river is the deer park. In this park there have been many landslides, from time immemorial. Great masses of earth would become detached from the bank and slide down toward the river. This is shown by the uneven surface of the deer park. In 1903 occurred an immense landslide directly between the mansion and the river. Large masses of earth extending from the middle of the hillside even to the brow slipped down to the sea-wall which has been constructed to protect the bank from encroachments of the river. Repetitions of this slide would destroy a portion of the lawn and soon endanger the mansion. If possible they must be prevented. In May, 1903, the superintendent, Mr. H. H. Dodge, and the writer of this paper examined the locality, and we agreed that drainage only could solve the problem. Mr. J. A. Archer, a mining engineer, became interested in the matter, and I quote at length his account of work, which he kindly furnished me:

"An investigation of the serious condition at Mount Vernon, caused by landslides, was begun in May, 1903. These slides threatened the entire deer-park front, from the entrance gate to a point some 200 feet southwest of the old tomb, a total distance of about 800 feet. It was found that back from the Potomac river a distance of 300 feet, and 50 feet above the river level, a series of springs and marshy places occurred. One of these springs showed a daily flow of about 3000 gallons and another 2500 gallons. It was decided to make a series of borings to determine the general formation, with a view of establishing the levels of these different water veins. It was found that all the springs and 'weeps' came out on a bed of blue clay of twelve feet to fifteen feet in thickness, under which was another water-tight red clay of thirty feet in thickness; then five feet of sandstone to river level. Resting on this blue clay, fifty feet above river level, was a bed of water-bearing sand that showed varying thickness from five to fifteen feet. Through

this evidently the water came, and when this sand was washed out the clay bed over it was let down, and a landslide was the result. Knowing now the levels of this blue clay, and finding only a five-degree dip to southwest, an attempt to find the general course of the underground water was made, and with success. A ridge north of Mount Vernon, known as the horseshoe ridge, was examined, and found to consist of Columbia river gravel, in which abundant water was found. This ridge is about four miles north of Mount Vernon. Standing on this we could look over the entire country towards Mount Vernon. A very distinct ridge was seen ending at Mount Vernon, forming one side of the frog of a horse's hoof. From the contour of the remainder of the country within the horseshoe, it was plainly evident that the Mount Vernon water must follow under this ridge. Outlet springs on the line were found all along the proper level lines. It was determined to run a tunnel under Mount Vernon at right angles to the general course of this central ridge, to cut the underground streams as nearly at right angles as possible.

"It was thought that possibly three tunnels would be necessary, and provisions were made for this. It may be added that wells on the estate were examined and the general water-level taken in these. Five feet was the general water-level. Depth of wells, seventy feet. Work was commenced on tunnel No. 1. Two feet of blue clay was carried in the heading at the start in order to take up the depressions in the clay which we of course expected and that were due to water wear. Running in on a grade of two inches to 100 feet for the first fifty feet, we experienced no difficulty, except great care was required to avoid runs of lower quicksands and falling of loose sands from above. At fifty feet we ran suddenly against a very hard sandstone, cemented sand and iron, five feet in thickness, with a footing on blue-clay level of one foot of pure white quicksand. In this sand cement we found numerous roots, some partly decayed, and some only the form of roots with the wood all gone, leaving simply a limonite shell. This material was singularly hard to break, and great care had to be exercised to prevent runs of quicksand underneath. The latter was stopped by the use of sand-bags and fine lawn grass. Hay or straw was of no use. We had now crossed at right angles several streams and had a flow of about 2000 gallons of water per day. After getting through this difficult piece of ground we suddenly came into a bank of solid sand, filled with water to the depth of five feet, and capped with two feet of putty clay that was well-nigh past picking

or cutting out in any way. The water flow immediately picked up to 50,000 gallons per day, and held to this for a long period. We were draining out the entire basin under the hill, for such it proved to be. The springs commenced to fail, the wells to fall in their water-levels; the dam was broken.

"The putty clay in heading lasted for nearly 100 feet and was very hard to manage, a special tool being made to cut it—a compromise between a mattock and the chisel point of a pick. Picks only went into it and drew out their width in clay. Mattocks could not be driven in deep enough to avail anything. After passing through this material a solid sand bed was encountered that required very careful handling to prevent its falling away from the putty clay, which had risen beyond the roof. This condition lasted to the end, a distance of 279 feet. Careful record had been kept of channels and slight depressions in the blue-clay level as the tunnel was driven. Each depression was marked in the timber sets. At the end we found a depression of four feet and six inches, and concluded that it was best to stop at this point. The drain had affected the old-tomb spring, one of our guides, reducing it by one-third; still with the clay depression at the end of the tunnel it seemed to be safer and cheaper (due to long haul) to cut No. 2 tunnel to isolate old tomb. It was necessary now to take up the depressions indicated in tunnel No. 1. A ditch with a grade of two inches to the 100 feet was started under tunnel No. 1, to take up the lowest depression, four feet six inches at its head. This tunnel had been timbered with a view to this. The timbers had been set four feet apart at the bottom and two feet at the top, so that a stringer could be run from No. 1 timber on the bottom to No. 3 on each side of the tunnel, and a jack placed across No. 2 timbers. This was tightened up and No. 2 mudsill taken out, thus swinging No. 2 so that the ditch could be cut out between these sets. This ditch was cut and the depression thus all taken up. The deepest depression had clay cores rammed down on the outflow side of the tunnel. This ditch was then filled, first with three inches of clear gravel from the size of a walnut to the size of a pea, thoroughly rammed. On this were laid three two-inch tile-drain pipes in pyramid form. The entire ditch was then filled in with the same gravel. The flow of water was 10,500 gallons per day. The springs and weeps as far as old tomb were practically dry. The well at the house, 150 feet distant from the tunnel, was dry. The greenhouse

well, 500 feet distant, was reduced by two feet. The old tomb spring was reduced one-third.

"Having now the exact conditions in the formation, and knowing the presence of the cemented dam around the hill, and its approximate width, we concluded to cut No. 2 tunnel to isolate the old tomb in blue clay, just carrying the sand level in the very top of the heading. The tunnel was driven in 125 feet. We encountered small streams of water as we went along, and broke through the limestone crust that lay between the blue clay and sand. Bore holes were made upward, so that we could feel our way across the iron dam. At 120 feet we commenced to get a good deal of water. All proper precautions were taken when we should break through under the dam. Sand-bags and grass were in readiness, and when, at 125 feet, we went into water-bearing sand, it was successfully held back and the water allowed to run out. The old-tomb spring stopped, and the tunnel was allowed to stand, except that a solid gravel filling was put in the heading in place of the grass and sand. This tunnel is to be filled with gravel, except near the mouth, where a cement wall, backed by a rammed blue-clay filling, is to be used as a dam, to back the water, to be carried off in pipes for further use. The water coming from the two tunnels is now cencentrated into a cistern that had been constructed some years ago, and is forced into tanks by hydraulic rams, from which Mount Vernon gets its supply of water. The supply has been sufficient for all general use. The flow is 15,000 gallons per day now, from both tunnels. No diminution can be detected in the flow of the two tunnels. No sand is observed in catch-basins. Everything seems to come to rest.

"CONCLUSION.

"The problem is successfully solved. The whole hillside affected by the tunnels has dried out. No. 1 tunnel, left for observation, is to be filled with gravel, so that a channel will be left that will never close up. The theory regarding the dam formed around the brow of the hill may be of interest, and seems to have been borne out by facts. The iron in solution in the water was deposited probably in the form of pyrite by coming in contact with the tree roots. This was gradually changed to limonite. Old trees died out (last slide had two dead stumps of very old trees at its head), and gradually in wet seasons the water dissolved the iron, and a break in the dam occurred, and this caused a landslide.

"A quite interesting thing has been observed recently, pointing

out to us how the waters in the upper levels to the north and west of us get down from the Columbia river level, fifty feet above the first sand level, to the lower sand level. In making the railroad cut just north of Mount Vernon a fault in the Columbian blue-clay base is shown for over 100 feet in length. The blue clay shows a continuous line for a long distance, but quite suddenly a fault is disclosed, the clay capping over a sand bed for some twenty feet; then a clear sand bed occurs for eighty feet. This would, of course, allow the water on the upper level to go through. As a matter of fact, this river-bed is now dry, whereas four miles back it carries the water."

VII.

MISCELLANEOUS PAPERS.

"THE STUDY OF MINERALOGY FOR SELF-CULTURE."
By J. C. COOPER, Topeka.

"MUTATIONS AND THE EVOLUTION OF MAN."
By ALTON H. THOMPSON, Topeka.

THE STUDY OF MINERALOGY FOR SELF CULTURE.

By J. C. Cooper, Topeka.

THE opening lines of Bryant's poem "Thanatopsis" invite to the study of nature in these beautiful and impressive words:

> "To him who, in the love of Nature, holds
> Communion with her visible forms, she speaks
> A various language: for her gayer hours
> She has a voice of gladness, and a smile
> And eloquence of beauty; and she glides
> Into his darker musings with a mild
> And gentle sympathy, that steals away
> Their sharpness ere he is aware."

The purpose of the writer at this time is to say something additional, in a general way, to encourage the study of nature, and later on to call attention more particularly to the inviting field of mineralogy.

There is no more instructive, delightful and useful recreation for man than the study of some branch of natural science. As the young student becomes acquainted with nature's works, their beauty and usefulness and perfect conformity to law, they teach him the most useful lesson youth or manhood can learn, that throughout the wonderful and complicated machinery of nature's works there runs everywhere the binding thread of law and obedience, holding every atom of matter in wise and loving subjection to its will. And man, being composed of atoms of matter, must obey these laws, so far as they concern him individually, as positively as inert atoms, or he will inevitably suffer the consequences. A violation of nature's law cannot be condoned by the purchase of indulgence. It must be worked out with repentance.

All of us, when in a crowd, probably have been impressed with the variety of faces that pass before us. No two of them are alike, and it is quite probable that in the whole human family there are no two persons exactly alike. This gives us a little idea of the variety in nature. As these faces differ, we may reasonably assume that each individual will differ in his internal laboratory and his mental and spiritual wants. Yet, with all this difference, the field of nature is varied enough to furnish delightful, instructive and useful employment and recreation for all, if one gets into the line of work he is qualified and adapted for.

Emerson says: "The crowing fortune of a man is to be born to some pursuit which furnishes him employment and happiness, whether it be to make baskets, or broadswords, or canals, or statues, or songs."

One can conceive of the delight in a pursuit that furnishes employment and happiness. But through the incongruities of life, resulting from ignorance of and departure from law, very few are so fortunate as to enjoy that happy combination. The careful study of nature's works, constantly impressing us with the perfection and inviolability of her laws, will help us to approach that enviable condition.

The diversity of human wants is illustrated in the field of natural history study by the direction that the individual tastes and inclinations lead. Some develop a natural inclination for a particular field of study, and if they are rightly started in it they are among the fortunate few whom Emerson had in mind. The study becomes a love with them; a love that sweetens labor and duty.

The three broad fields of nature's works, animal, vegetable, and mineral, are subdivisible into numerous branches. A better acquaintance with any one subject discloses a wide field, again subdivided into specialties. Those who give the subject most thought and study, in any direction, find that greater excellence can be obtained by concentration upon a small field of work.

Application and industry educate the eye as well as the hand. The enthusiastic entomologist will catch the glint of a beetle's flight across his path when thousands of people would not see anything.

The writer, at one time, was showing some pretty minerals to a country friend who had his son with him, a stout boy of nineteen years of age. The boy asked, with astonishment, "Where did you get those things?" He was told that these had been picked up in rambles over the country, when he exclaimed, "I never see anything like them." And he did not—and comparatively few people do. Excellence acknowledges no guaranty but labor, and it takes the trained eye to catch the flight of a beetle, or the form of a fossil, or a crystal in the rock. Even the hues of the earth and the blue of the sky have no beauty for some people. The eyes might transfer to their soul the granduer of what they could take in in a sweep, but they don't. In fact, we might almost believe we were daily among men who

> "Could strip, for all the prospect yields
> To them, their verdure from the fields;
> And take the radiance from the clouds
> With which the sun his setting shrouds."

Mineralogy more intimately concerns the human family than any other branch of natural science. All the elements that enter into the composition of matter are mineral. Our bodies, the earth we live on, the air we breathe, the water we drink, the food we eat, all the articles of use that minister to our necessities and comforts, all the articles of ornament that adorn the homes of luxury, all the colors of paint upon the artist's palette, the bloom on beauty's cheek, and the flowers—"those reminisences of Eden and prophecies of heaven—the splendid children of the sun and the jewelry of the soil," are all made up of and are resolvable into mineral elements.

Nature invites to this study by adorning the material with the beauties of all the gems. She fashions from the most common materials her most beautiful and precious gems. From carbon, an abundant and common mineral, which, as coal and charcoal, contributes so much to our necessities and comforts, by an art that man has not yet been able to imitate profitably, she fashions the diamond.

From the abundant element, aluminum, which makes up, probably, one-tenth of the entire earth, combined with oxygen, another common element which makes up about one-half of the earth, she makes the sapphire, the oriental or true ruby, the oriental emerald, the oriental topaz, and the oriental amethyst. These, when found perfectly crystallized, and composed of pure oxide of aluminum, with a little coloring matter from some mineral oxide, are among the most valuable gems known. The pure aluminum ruby, when of perfect color, is more valuable than the diamond. Nearly all the favorite gems, next in degree of value to the diamond, and the pure oxide of aluminum, are varying oxides of aluminum, silicon, and iron, with occasional oxides of a few other metals.

It is exceedingly interesting to study this feature of nature's work—how she makes her most beautiful gems out of the most abundant and common mineral. Like, in our republican form of government, where the human elements have free opportunity to develop, we bring forth our Lincolns, Garfields, Grants, and nearly all the leading minds in commerce, in the industries, in art and literature, from the common material of society. There is hardly a distinguished man in this country to-day who has not, in this, or only a few generations back, come up from the common people.

The sentiment of mineralogy is abundant and beautiful; but it will be more interesting to practical minds that are anxiously concerned about their daily needs to consider, more particularly, the practical uses to which this study can be applied.

There seems to be a wise forethought and lawful purpose in all of nature's work. She has crystallized all the common and many of the rare minerals into beautiful forms and adorned them with attractive colors, and many of them with a luster of finish that rivals the lapidary's art, evidently to attract our attention and get us interested in them. An acquaintance with their beauties of form and color naturally leads us to want to know something of their composition and useful properties, and this want invites to the study of the chemistry of mineralogy, which opens up more of the useful secrets of nature's work, for man's necessities, health, and comfort, than any other department of natural science.

The field of the practical uses to which mineral atoms can be applied is so broad, it so intimately concerns all our material wants, that it furnishes infinite employment for human pursuit. The mining and fabrication into useful and ornamental forms and compositions of all the metals—of gold, silver, iron, aluminum, zinc, lead—the varieties of useful rocks, the alkalies and clays, give employment to the most varied talents. A little reflection will impress the student with the useful fields this study opens.

All the elements made known by chemistry are found in minerals, for the mineral kingdom is the source of whatever living beings—plants and animals—contain or use.

"The chemist cannot make anything; he only supplies the favorable conditions for the action of the laws that absolutely govern every atom of matter."

Having shown that mineralogy deals with all the elements that make up this earth and all that there is on it, and, in all probability, all matter of every kind throughout space, its usefulness cannot be questioned.

The writer has been surprised at the lack of interest manifested in this particular department of natural science in our collegiate institutions. Fossil geology, or paleontology, seems most to interest them. Perhaps they have become so accustomed to devote study to dead languages and dead things that they do not appreciate the vitality of the living present and the prospective activity of the coming future.

The writer's attention was particularly attracted recently, upon the receipt of a circular from the University of Chicago, to a list of professors under the head of "department of geology." This list enumerated seven different subdivisions of this department, with a special professor at the head of each. These subdivisions were: "Head professor of geology," "professor of geographic geology,"

"professor of petrology," "professor of economic geology," "professor of pre-Cambrian geology," "professor of paleontological geology," and "professor of archeologic geology," but not a single professor of mineralogy.

Some time ago when in Chicago, the writer visited that great institution, which already has cost many millions of dollars, and inquired for their mineral collection, and was informed that they did not have any. It was suggested that such an institution should have a good collection of minerals to assist in their educational work. They gave as the reason for not having any minerals that they did not have money to spend for them, although they were about to invest a good many thousands of dollars for some bones of gigantic fossil animals of the Carboniferous period which had been discovered in Utah.

I felt a good deal like saying that we were not living in the Carboniferous age now, and that something pertaining to the present day and its practical work might prove a great deal more useful.

Mineralogy is preeminently a practical science. It is in direct contact and intimately associated with the activities of to-day. It holds in its wide domain more of interest to the future of humanity than any other branch of natural science.

Microscopic mineralogy is a very pleasing and attractive branch of the study. Nature has, in a measure, concealed many of the most exquisite beauties of her work in such minute forms that it requires the most powerful microscope to develop their beauties. One great advantage of this branch of the study is in the small space required for a collection. Many have been deterred from collecting minerals because the material is so bulky, and requires a great deal of space to exhibit it to advantage. This objection is done away with in microscopic mineralogy. The writer has a friend and correspondent in Philadelphia, a gentleman of wealth and excellent taste, who devotes his whole attention to microscopic work. It is a great pleasure to look over his collection, which pretty well covers the field of amateur mineralogical study. It was contained in a few small cabinets, or boxes of drawers, each about one foot square, which could be picked up like a satchel and carried about anywhere. He had a small room which he called his "den," about twelve feet square, a round table about three feet in diameter, the top of which revolved freely. We sat on one side of this table, with my friend opposite. He would take out one of his mounted specimens, which did not occupy more than a square inch of space,

and, placing it under the large binocular microscope and adjusting the focus, would turn the top of the table around so that the microscope with its object would come in front of myself for observation. In that little room we spent a delightful evening looking at the beauties of the mineral kingdom, exhibiting the most perfect crystallization, and gorgeously beautiful in color. Crystals so minute that they could not be seen by the naked eye appeared under the microscope as large as sections of a lead-pencil. It was a great pleasure to discover that quite a number of his most beautiful and rare gems were some that the writer had picked up on old dump piles in New Mexico and Arizona and had sent to him.

The microscope discloses the fact that a great deal of nature's most perfect and beautiful work in the mineral kingdom is in minute forms. Large minerals require the natural and best light of day to bring out their beauties, but these little gems under the microscope can be seen to advantage and studied by artificial light.

Something should be said to encourage the youth—the boys and girls—to become interested in this study. It does not cost much to get a few interesting specimens of minerals for them and some rudimentary works on minerals. A little later a microscope will open a new world of beauties to them. Then the determination of them will give them endless employment and happiness. It will bring them only good, and keep them from a great deal that might be harmful. It is healthful, physically and morally, instructive and entertaining.

It makes a very attractive and interesting study and recreation for women. There is nothing so attractive to an esthetic taste as the gems of the mineral kingdom. One cannot conceive of a more delightful recreation for a cultured woman than to gather these gems and study their varied forms and beauties. By gems is not meant, what a good many would suppose, the costly gems, but the gems of the mineral kingdom—small, unique and good crystallizations of the minerals. The gathering of these is not confined to the minerals that are found in the neighborhood. They can be obtained at moderately reasonable prices from houses that deal in minerals and by exchange with collectors in other localities. When a collector finds himself or herself in possession of a number of duplicates of any mineral, by the possession of a copy of the Naturalists' Directory, a book that is published giving the name and address of all known collectors, with their specialties, he can select persons to correspond with who are interested in the same line of work, and learning what his correspondents have to ex-

change, he can work up a profitable and pleasant exchange, thereby getting acquainted with many pleasant correspondents, and adding to his knowledge of minerals and to the enlargement and variety of his own collection.

To the aged and those pretty well advanced in life, who have given some study to this subject, the collection of minerals furnishes an endless and interesting source of recreation and instruction. When disappointments and cares oppress them their minerals will always meet them with a friendly countenance and an amiable disposition. They are always teaching something, and they do it so kindly and so thoroughly that they prove most agreeable companions.

No matter how one may feel depressed by human ingratitude and want of sympathy, when one turns to his minerals for companionship and friendly counsel they will not be a source of disappointment. They will disperse the demons of despondency and unrest, and open up fields of study in God's works that so beautifully illustrate the perfect laws of wisdom and love with which the Great Master rules His universe, so that hatred, sadness and disappointments will leave the mind, and a cheerful spirit will take their place and give renewed courage and hope.

The field of this inviting study is illimitable, and the worlds to conquer are always waiting for industrious and enthusiastic effort.

MUTATIONS AND THE EVOLUTION OF MAN.

By ALTON H. THOMPSON, Topeka.

THE discovery and demonstration of the principle of mutations in the formation of species and varieties of plants, by Hugo De Vries, is one of the most brilliant achievements in the history of evolution since the publication of Darwin's "Origin of Species." Its recent promulgation has thrown a flood of light upon many puzzling and obscure questions, and has aided materially in the solution of some intricate problems in the science of biology. Of course, there is danger of carrying it too far in its application, like all revolutionary discoveries, for after all it only supplements natural selection and assists in solving problems that that great principle could not account for. It is a source of wonder to later scientists that Darwin, with all his observations and great insight into the workings of nature, should have failed to perceive the idea of sudden mutations, and held it as an inviolable principle that all changes of structure were due to very gradual alterations, the result of natural selection.

Darwin succinctly states his doctrine in a letter to Haeckel, as follows: "Having reflected much on the facts, it seems to me probable that allied species were descended from a common ancestor. But during several years I could not conceive how each form could have been modified so as to become so admirably adapted to its place in nature. I began, therefore, to study domesticated animals and plants, and after a time perceived that man's power of selecting and breeding from certain individuals was the most powerful of all means in the production of new races. Having attended to the habits of animals and their relations to surrounding conditions, I was able to realize the severe struggle for existence to which all organisms are subjected; and my geological observations had allowed me to appreciate the duration of past geological periods. With my mind thus prepared, I fortunately happened upon Malthus's 'Essay on Population,' and the idea of natural selection through the struggle for existence at once occurred to me."

So it remained for the astute mind of De Vries to perceive that sudden changes of structure were possible, and under certain conditions could be made permanent. The general acceptance and the revolutionary effect of the idea of the origin of species by mutations has been marvelous, and is second only to the revolutionary

wave that swept over the world of thought following the publication of the "Origin of Species."

Hugo De Vries says of the previous condition of the science of origins (in speaking of Burbank's work) that, "Of great scientific importance is the question whether repeated selections are sufficient to bring about new forms, and, further, if by this means more variations are produced. We have no facts to indicate this, but it has great importance in the study of conditions. It is closely connected with the question whether species slowly merge into one another or whether they originate by mutations. In the former case small deviations would increase in the course of generations, and thus a long series of intermediate forms would connect man and all other species. In the latter case of mutations a jump is made without any intermediate stages."

The doctrine of mutations is founded upon seven laws, which De Vries thus states: "(1) New elementary species appear suddenly, without intermediate steps; (2) they spring latterly from the main stem, not affecting it; (3) they attain their full constancy at once; (4) some of the new strains are elementary species, others are to be regarded as varieties; (5) the same new species are produced in a large number of individuals; (6) mutations undergo fluctuating variation, but the latter is not evolution; and (7) mutations take place in nearly all directions."

Like Darwin, his great discovery was founded on experimentation, elaborate and long continued, and he worked upon well-known and familiar facts. Stock-breeders and horticulturists have long employed the method of making permanent the sudden changes that produce variations, but no one before ever attempted to formulate the facts of mutation into a law and to conduct investigations upon such a basis.

Prof. Chas. A. White thus well summarizes the subject in *Science:* "Species originate from other species through the ordinary function of reproduction, but they each originate suddenly and completely by one mutative act, and not by the slow accumulative variations of individuals. The beginning of the mutative process which is due to some unknown natural determinative cause, some molecular change in the germ-cell of the fertilized ovum, whereby the new individual acquires changed structural characters. The new species thus produced by mutation is in immediate possession of clearly distinguishing and hereditarily transmissible characters, and it has no more tendency to hybridize with any other member of the mother species than have other species. Strains

thus produced are called elementary species, and differ distinctly but not widely from the mother species."

It is well known that geologists have long been dissatisfied with the theory of natural selection by the accumulation of slow progressive changes as the one method of the origin of species.

Professor White again says: "There has been an increasing distrust of the theory of natural selection for the origin of species that Darwin proposed a half-century ago, and it has been especially felt in endeavoring to apply it to certain lines of paleontological investigation. It has been regarded with growing disfavor in such cases, as it is shown that genera, families, orders and classes of animal and plants have, during geological time, usually originated with such comparative rapidity as to make it necessary to infer that species have originated suddenly; that the ratio of progressive development has not only not been uniform, but has been exeedingly diverse; that environment had little to do with the origin or destruction of species. These and other items made it necessary to presuppose some other theory for the sudden origin of species to harmonize them with the past conditions which they reveal. After the fishes and reptiles, a sudden change marks the introduction of the placental mammals which occurred about the beginning of Tertiary time. These highly organized animals assumed faunal dominion of the earth which the decadent dinosaurs had just departed from. They came in great diversity of forms, and their organization was little if any inferior to that of the mammals now living of lower grade than the Quadrumana. There has been found no evidence of evolution from earlier forms by any slow process, and they became extinct at or before the close of the Eocene epoch. They were succeeded by the Miocene and Pliocene mammalia, exhibiting many strange and suddenly introduced forms. Indeed, the history of the mammalia from the earliest Tertiary to the present time embraces a record of rapid and varied evolution of the highest grades of animals, culminating in man. If it should ever be possible to trace the evolution of man from the lower animals, it will probably be found that it has been accomplished, not by the slow process of natural selection, but by a series of sudden mutations."

Indeed, the theory accounts for much in the evolutionary history of man that has been lacking. In the first place, his geological history is quite insufficient to allow of his gradual development, according to the theory of natural selection, by slow accretions of alterations. The earliest form of lemur, *Anaptomorphus*, which was probably the ancestor of all of the Anthropoidæ, is too recent

to allow time enough, geologically, for the slow evolution of man from this stock. We have reason to believe that the psychic emergence of man from lower forms was a sudden mutation, and from the start his mental evolution took place by leaps and bounds. All of his physical alterations and his special brain and mental development indicate such a process of sudden mutations. To be sure, the gap between man and the highest anthropoids has been materially lessened by the discovery of *Pitheconthropus* and the studies of the pygmies, but there are still many missing links which were necessary according to the theory of natural selection. With the principle of mutations, however, we can dispense with these links in the formerly supposed necessary chain, and observe how perfectly the wonderful theory of mutations can account for perhaps all of the marvelous changes that have taken place in the evolution of man.

The theory of mutations will alone account for the psychic emergence in relation to its necessary suddenness and the successive rapid changes that took place in the growth of the brain in response to higher mental activity and the correlative changes in physical structure. The theory of selective influences and the slow accretion of alterations has never been satisfactory, and has bitter opponents. The early geological horizons in which stone implements of supposedly human manufacture have been found, the authenticity of which has never been satisfactory, need not trouble the anthropologist now, for it is possible that man could have emerged as suddenly as many other animals which the geological history of the earth has demonstrated. The problem of man's origin is now in a fair way of being solved and fills us with excited expectation. We can accept with confidence now the evidence of his existence in early geological formations, which we have felt heretofore that we must reject as impossible. The geological evidences of the earliest occurrence of man, are now trustworthy, and we can accept them without the reluctance with which we have heretofore regarded them. We can now believe in the possibility of Pliocene man, and the disputed questions of the probability of early Pleistocene man are at once settled. All the implements of early man can now be accepted as genuine, and perhaps a flint chip from the Miocene even, which we have held as being impossible of human workmanship, we may now regard as possible.

Not only does early geological man thus become a certainty through the theory of mutations, but it will also throw much light upon later and other anthropological problems; for instance, the

question of the origin of races, which has always been a most difficult one. That the great variations of mankind could have arisen merely through the influence of environment, climate, food, terrestrial or cosmic influences, which were tentatively offered, owing to the theory of slow changes, we have been long convinced are not sufficient. We now feel satisfied that the great racial variations originated suddenly, by mutations, and that from "sports," so to speak, the races had their origin. The mutation theory throws a flood of light upon this great question, but which awaits the working out of the details.

The theory accounts also for the origin of very early civilizations, which we have heretofore believed must have had a slow growth by natural development. We can now realize how a superior race could spring into prominence, and, by unusual ability, rapidly evolve a high civilization; as witness the ancient Assyrians, Egyptians, Greeks, Romans, Peruvians, Mexicans, and others. History tells us that the rise and development of such peoples were very rapid, and that a very few centuries were required for them to progress from savagery to high civilization, and which we now know must have been due to mutations—to the sudden appearance of superior intellects without a previous gradual development. Modern nations also have arisen into intellectual prominence and accomplishments by leaps and bounds, as many examples that occur at once to every one will amply prove. At the present time we need some moral mutations to correct the aberrations of conscience of men in high places.

Indeed, the idea opens up an illimitable field for speculation. As a recent writer in *Science* well said: "Born in the womb of lower animals, man has become the most wonderful living thing on earth, although separated now by a great gulf from his next of kin. Inexperienced in his early history, his mind steadily advanced, until to-day he contemplates all nature with a yearning to know its mysteries. The changes in the germ-cell sufficing to evolve him are as inscrutable to his reason as the constitution of matter or the interstellar space ether, or the origin, nature and the meaning of life itself. But we ardently desire to know these things—to peer out into unfathomable space and to speculate upon the meaning of our existence and the unknowable as we perceive it all about us in the universe. But as a species, *sapiens*, of the genus *Homo*, we can never know. We seem to be but intellectual atoms floating in an infinity of space and time."

VIII.

ANNOUNCEMENTS, ETC.

ANNOUNCEMENT.

IT HAS long been the desire of many of our members to secure the annual publication of our Transactions, but not until this year has it been possible. By assurances that the total expense to the state would not be increased beyond the sum heretofore granted, we were able to secure assent of the printing committee, and now issue volume XX, part I. The volumes will be numbered biennially, as heretofore, and the larger part of the edition will be in paper covers, which facilitates their distribution in foreign countries, and does not lessen the value for exchanges. If our next meeting be held in Thanksgiving week, and the papers presented are promptly handed in, it will be possible to get them into the printer's hands before the rush of legislative printing occurs, to delay their publication.

We have secured the reprinting of our four lacking volumes—IV, V, VI, and VII, and now can supply missing numbers or complete sets to any of our members at very moderate expense. In accordance with the usage of other societies, it is likely that a liberal discount will be made to members from our list prices, although these are not high.

The secretary would like expression from the members as to choice of time and place for next meeting, that these preferences may be laid before the executive committee of the Academy.

J. T. LOVEWELL, *Secretary.*

TOPEKA, March 9, 1906.

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